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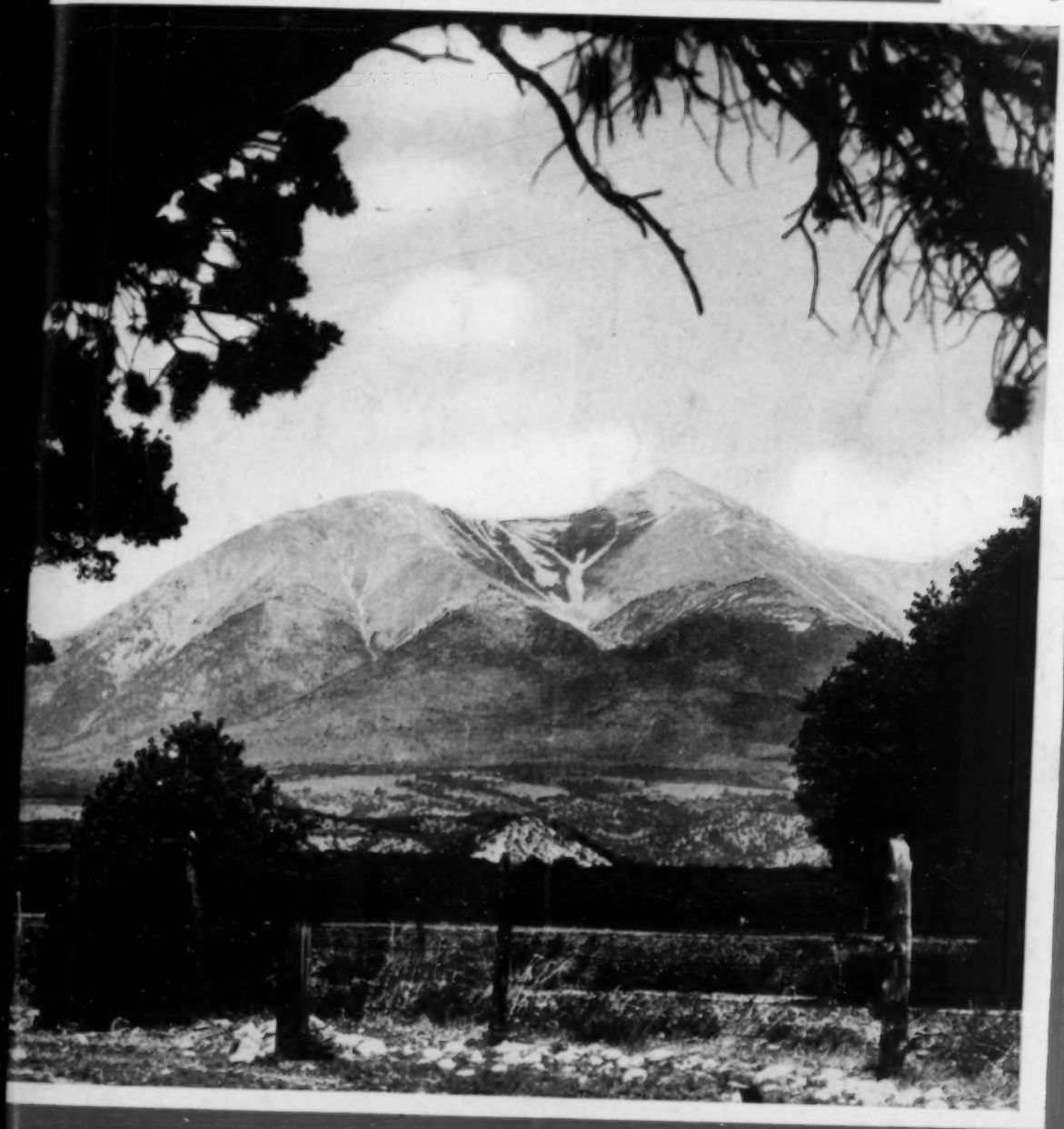


ANGEL OF SNOW ON MT. SHAVANO

Natural manifestation that appears each year on Colorado peak

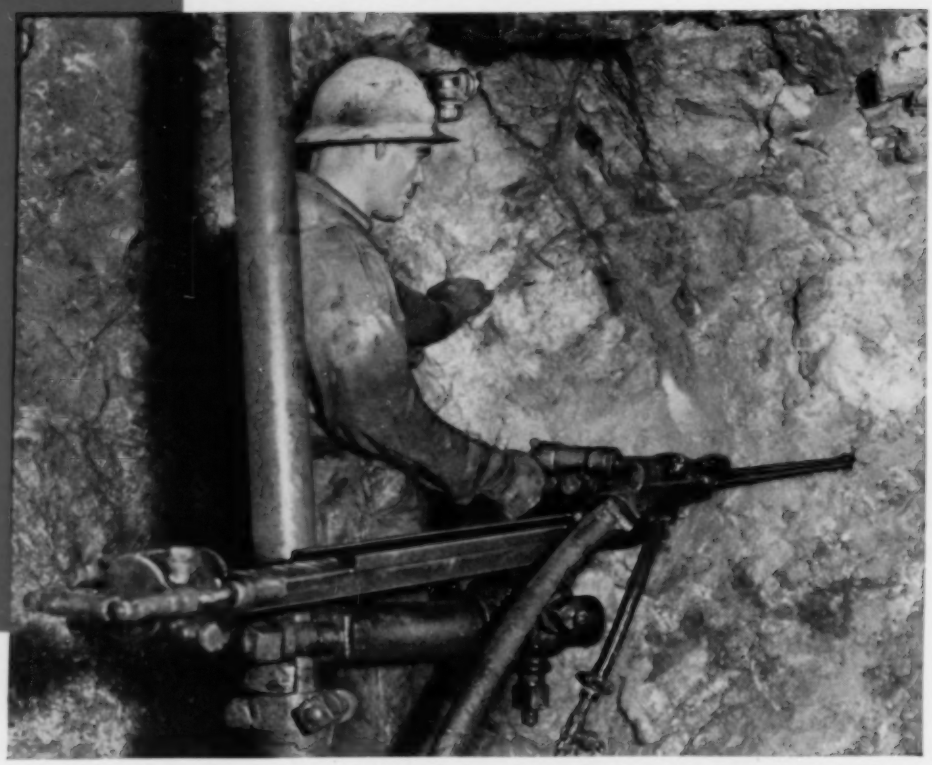
(Photo by Henry R. Hay)

VOLUME 53 · NUMBER 4

NEW YORK · LONDON

TOUGH DRILLING MADE EASY

You'll drill more footage . . . at lower cost . . . with the 6-way protection of Texaco Rock Drill Lubricants E P



WHEN you lubricate your drills with *Texaco Rock Drill Lubricants E P* you give them the greatest possible protection against six common causes of drill failure—cracked piston flutes, burned rifle bars, excessive rifle nut wear, corroded chucks, scored piston heads, and rusted cylinders.

Texaco Rock Drill Lubricants E P have ample film strength to protect moving parts under the toughest operating conditions. They resist wash-off, and gum and carbon formations . . . maintain proper fluidity at low temperatures . . . inhibit rust and corrosion in your drills, running or idle.

Texaco Rock Drill Lubricants E P meet the specifications of leading rock drill manufacturers . . . and are preferred by operators everywhere. Use them and note the improvement in your drill operation . . . the reduction in your drill maintenance costs.

A Texaco Lubrication Engineer will gladly give you full details. Just call the nearest of the more than 2500 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Lubricants

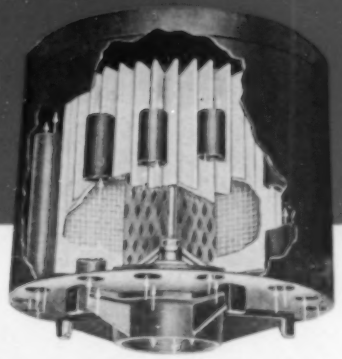
FOR ALL AIR COMPRESSORS AND TOOLS

Tune in . . . Texaco Star Theatre every Wednesday night featuring Gordon MacRae, Alan Young, Evelyn Knight: ABC Network

IT FILTERS!

IT SILENCES!

CUTAWAY VIEW



STAYNEW MODEL DS INTAKE FILTER

Both silencing and filtering in a single compact unit! All the outstanding advantages of the original Staynew Dry-Type Radial Fin Construction: low resistance to air flow; increased efficiency with use; suitability for use on carbon ring compressors; no oil, viscous coating or charging tanks; no moving parts; inserts easily and inexpensively cleaned or replaced.

Silencing is efficiently handled without excess back pressure thru a series of cylindrical rectifying chambers of scientific diameter to length ratio.

Thousands of these well-designed, well-built Staynew Filters are already in use, saving wear on compressor and internal combustion engines, reducing intake clamor.

FOR COMPLETE DETAILS WRITE:

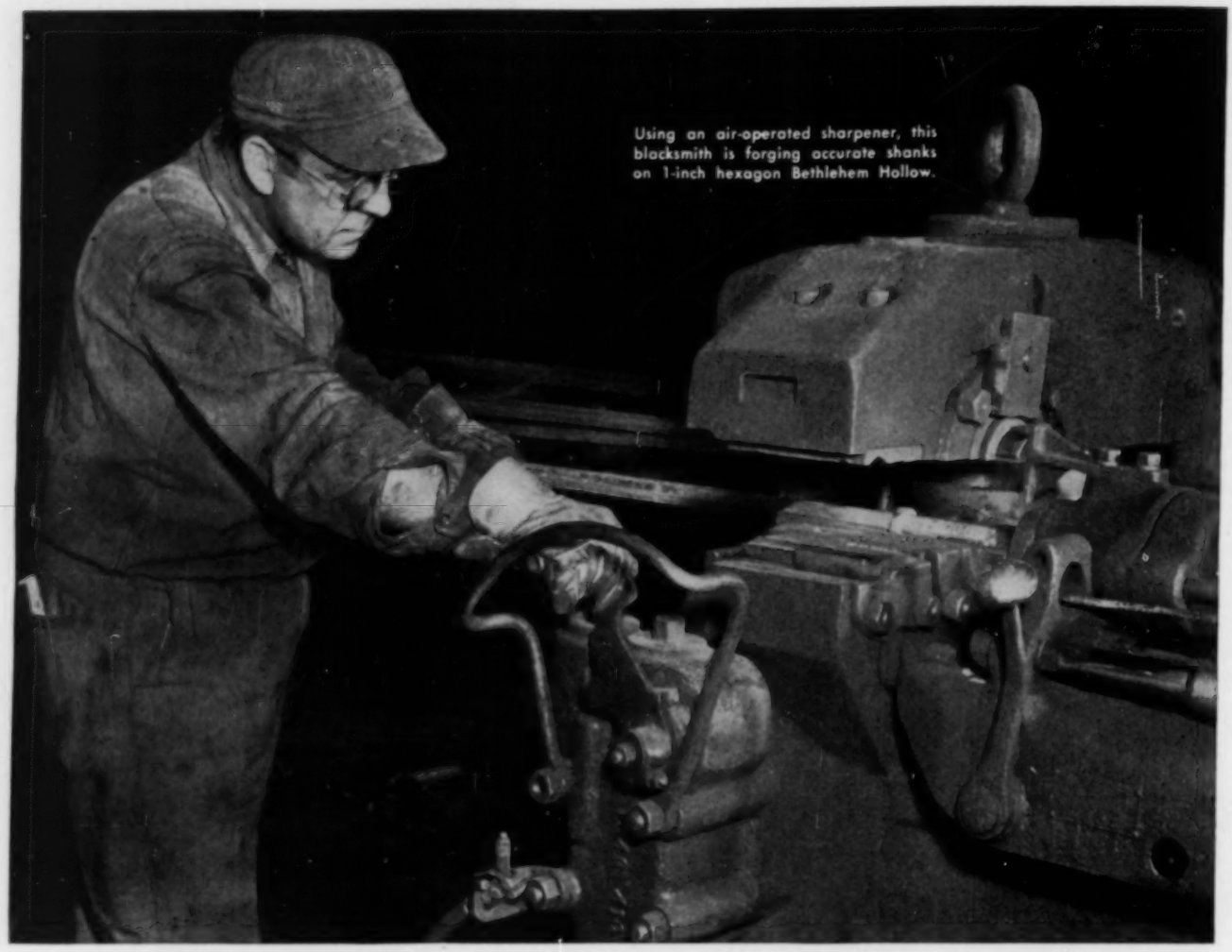
DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

DOLLINGER CORPORATION

7 CENTRE PK., ROCHESTER 3, N. Y.

REPRESENTATIVES IN PRINCIPAL CITIES

IN CANADA: McCarthy and Robinson, Toronto — Engineering Equipment Co., Montreal



Using an air-operated sharpener, this blacksmith is forging accurate shanks on 1-inch hexagon Bethlehem Hollow.

ASK HIM ABOUT DRILL STEEL

An experienced blacksmith will tell you it doesn't pay to use any but the best quality drill steel. And he should know, for he's working with steel every day. His skill and his practical knowledge of forging and heat-treating have a lot to do with the amount of rock drilled per shift.

Like all craftsmen, the blacksmith wants to work with the best possible equipment and materials. Ask him about drill steel and he'll tell you he wants easy forging, a wide quenching range, a smooth center hole . . . and above all, a steel that's uniform from bar to bar.

That's a perfect description of Bethlehem Hollow Drill Steel.

Whether used for forged-on or detachable bits, there's no better steel for hard-rock drilling. It's available for prompt shipment from your nearest distributor or converter. Ask for "Bethlehem Hollow," not just "drill steel."

★ BETHLEHEM STEEL ★

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL

NOW

YOU CAN PLAN YOUR OWN

MOTOR CONTROL CENTER

Self-enclosed interchangeable units give you . . .

MORE COMPACT ARRANGEMENT

REDUCED MAINTENANCE

GREATER FLEXIBILITY

These new starting units come in four sizes to fit a wide range of motors. You can plan your own motor control center by simply taking an inventory of your motors and then adding up the space sizes of the starters needed.

Let us send you our publication GEA-4979 which will give you detailed description and ordering information. Fill in the coupon and mail it to us. Apparatus Department, General Electric Company, Schenectady, New York.

GENERAL ELECTRIC

Apparatus Department
Section No. M676-262
General Electric Company
Schenectady 5, N. Y.

Thanks . . . I'd like to have your publication GEA-4979 on the new G-E Motor Control Center. Will you please address it to me as follows:

Name .....

Address .....

City and State .....

HOUGHTON OFFERS ROCK DRILL OILS THAT:

. . . have high film strength to withstand shock loads

. . . eliminate "fogging" and toxic gases

. . . do not "blow" readily, nor interfere with valve action

. . . lubricate perfectly at all operating speeds

. . . are non-corrosive; do not form gummy residues

. . . wet out all parts rapidly; are high in oiliness

Less oil...
Less often...

Houghton's Sta-Put Lubricants for pneumatic tools are treated to give them great cohesion, and to enable them to adhere to metal surfaces. They resist leakage . . . *stay put,* as their name indicates.

Further, they are also treated to carry heavy loads. They permit maximum drill speed for longer periods. And they won't fog, gum or corrode.

For all those reasons, mining men, excavating contractors, quarrymen—everyone who uses air-operated tools—praise Sta-Put Lubricants. They're supplied only by E. F. HOUGHTON & CO., Philadelphia and all principal cities.

HOUGHTON'S STA-PUT
ROCK DRILL LUBRICANTS

HERE'S WHY NEOPRENE PRODUCTS DO SO MANY JOBS SO WELL

They resist
SUNLIGHT AND WEATHERING—in a class by themselves in resistance to rubber's worst enemies.

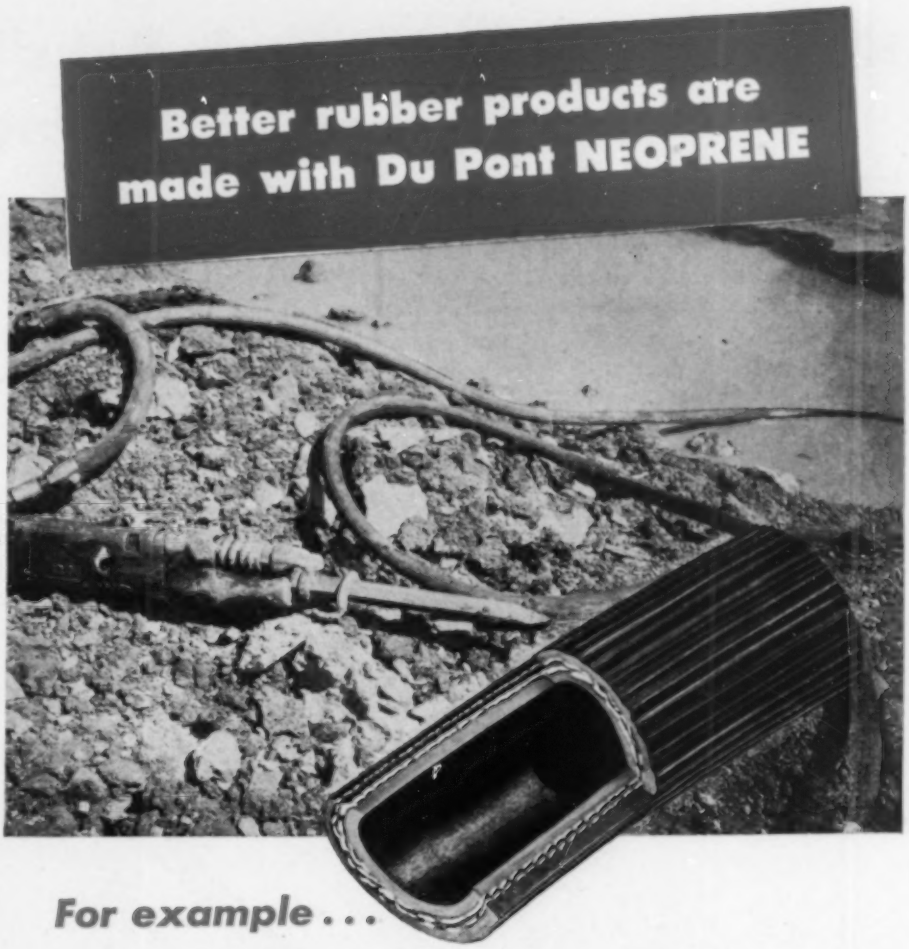
They resist
AIR AND GAS DIFFUSION—have low permeability to gases—retain air longer.

They resist
HEAT—are exceptionally stable at temperatures up to 250° F.

They resist
OILS, SOLVENTS, MOST CHEMICALS—set the standard for oil resistance throughout industry.

They resist
LOW TEMPERATURE STIFFENING—retain flexibility at sub-zero exposure over long periods.

FREE! THE NEOPRENE NOTEBOOK—Interesting stories...new, unusual applications of neoprene. Write E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division Y-4, Wilmington 98, Delaware.



For example . . .

Air hose that's still in use after two years' service on a portable compressor

Two years of continuous service and still on the job! That's the record of this air hose . . . made with neoprene tube and cover and reinforced with rayon braid. This was tough service, too. Many lengths of ordinary hose had blown out in a very short time. When the neoprene hose was installed, it was connected directly to the manifold and tool. No whip ends were used. The hose was often overloaded and plenty of hot lubricating oil passed through it.

A sample of this hose pictured above tells the story. Even though the tube is covered with oil film and dried residue, it's not swollen. Original fittings are still being used. There are no soft spots either . . . spots that show tube disintegration . . . the cause of tool clogging and blowouts.

Consider the cover. It's been exposed to searing sun, driving rain, sub-zero cold. The hose has been yanked and pulled over jagged terrain. Yet there are no cracks . . . no cuts and chips of any consequence.

You, too, can put an end to the expense and annoyance of constant hose replacement, just as this contractor did. Ask your supplier for portable compressor hose made with neoprene tube and cover. Job tests have proved its superiority.

Tune in Du Pont "Cavalcade of America" Monday nights—8 p.m. EDST, NBC

For better equipment specify

NEOPRENE

The rubber made by

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

No worry about "weak links" when all piping is Crane

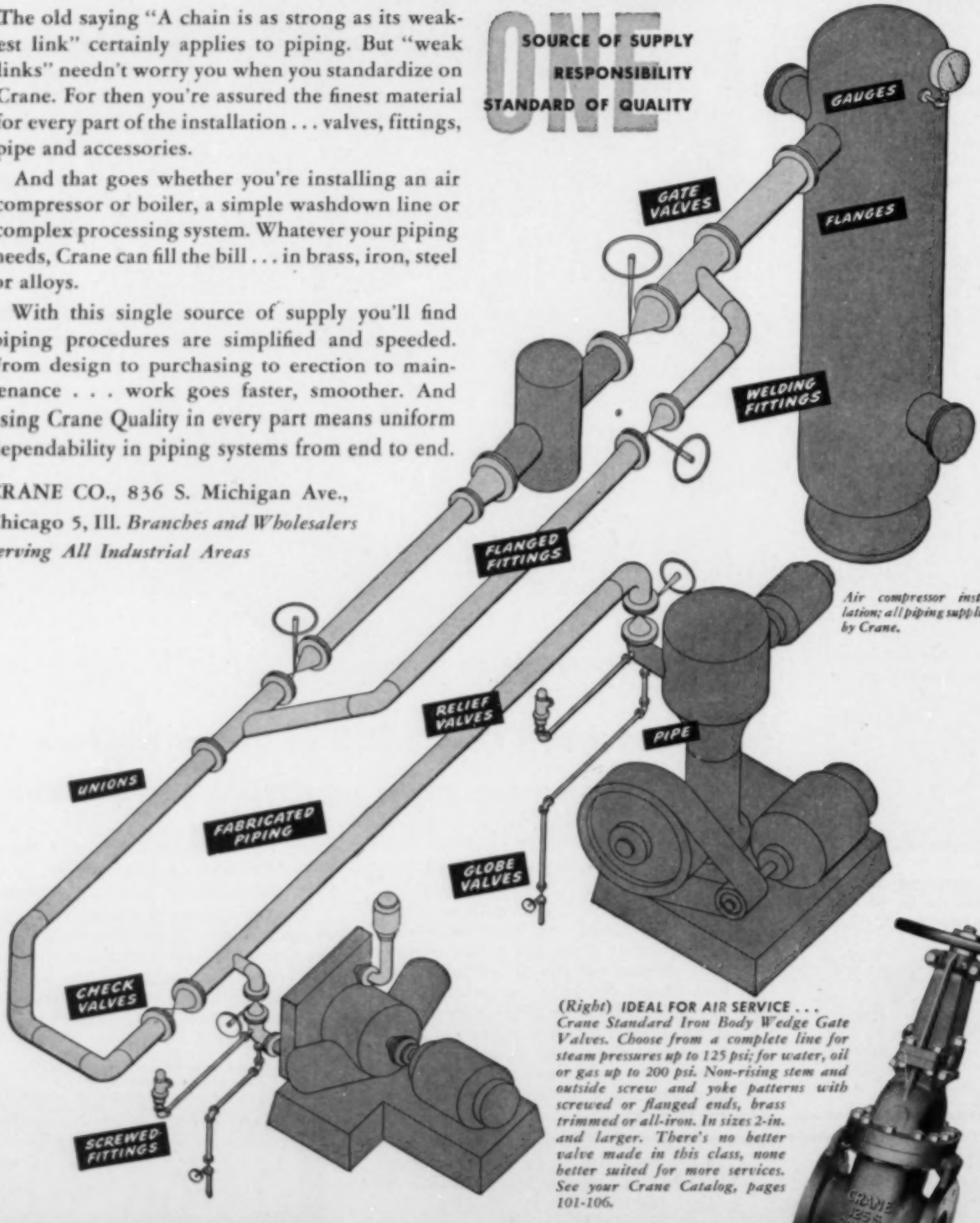
The old saying "A chain is as strong as its weakest link" certainly applies to piping. But "weak links" needn't worry you when you standardize on Crane. For then you're assured the finest material for every part of the installation . . . valves, fittings, pipe and accessories.

And that goes whether you're installing an air compressor or boiler, a simple washdown line or complex processing system. Whatever your piping needs, Crane can fill the bill . . . in brass, iron, steel or alloys.

With this single source of supply you'll find piping procedures are simplified and speeded. From design to purchasing to erection to maintenance . . . work goes faster, smoother. And using Crane Quality in every part means uniform dependability in piping systems from end to end.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas*

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Air compressor installation; all piping supplied by Crane.

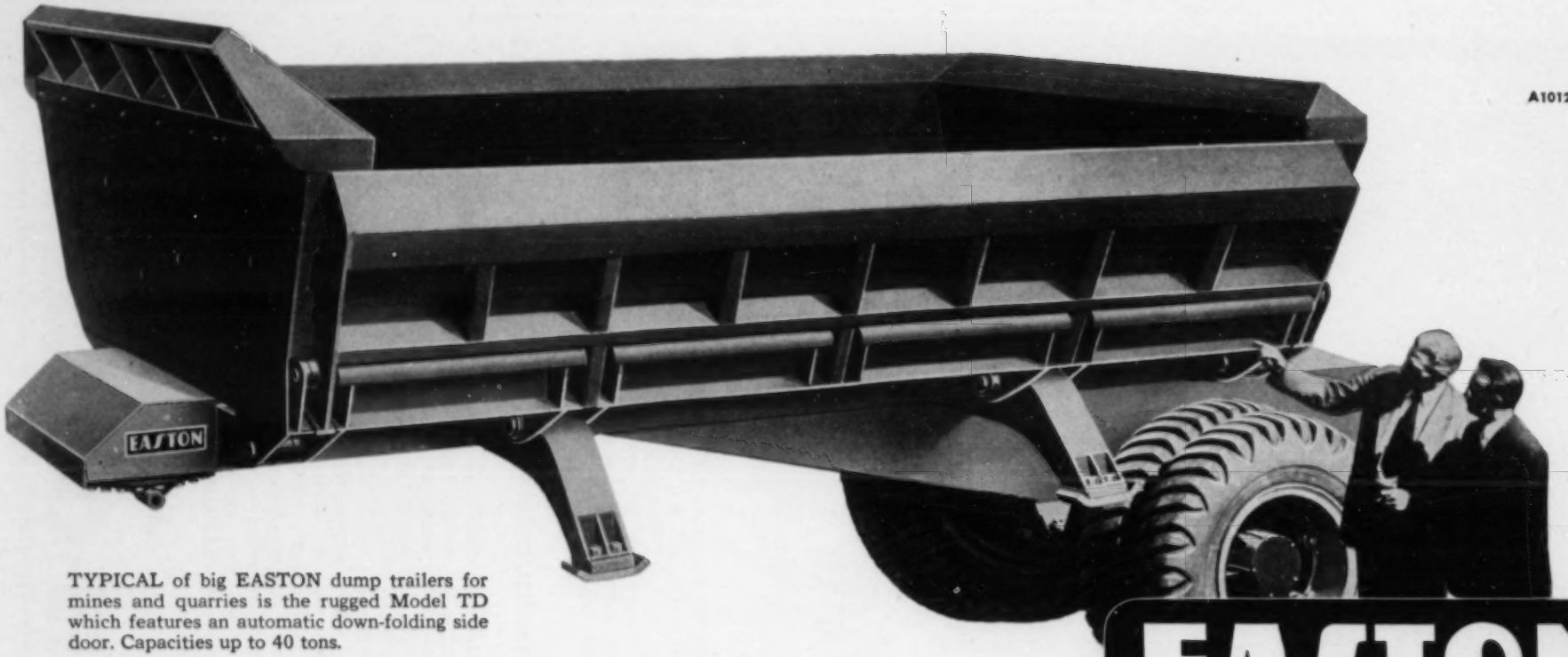
(*Right*) **IDEAL FOR AIR SERVICE . . .** *Crane Standard Iron Body Wedge Gate Valves. Choose from a complete line for steam pressures up to 125 psi; for water, oil or gas up to 200 psi. Non-rising stem and outside screw and yoke patterns with screwed or flanged ends, brass trimmed or all-iron. In sizes 2-in. and larger. There's no better valve made in this class, none better suited for more services. See your Crane Catalog, pages 101-106.*

EVERYTHING FROM . . .

VALVES . FITTINGS
PIPE . PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM



A1012

TYPICAL of big EASTON dump trailers for mines and quarries is the rugged Model TD which features an automatic down-folding side door. Capacities up to 40 tons.

TO MOVE *BIG* LOADS AT LOW COST . . . EASTON Trailers

PORTABILITY is the advantage featured in this specially designed EASTON trailer, which mounts a 1500 gallon chemical storage tank.

Speed, flexibility, lower costs, and the ability to move bigger loads with less power—these are some of the advantages which have helped to introduce the trailer idea to mines, quarries, industrial plants and other off-highway haulage operations. Application of the proved advantages of big, pneumatic-tired trailers to new fields of off-highway service has followed the initiative of foresighted plant operating executives. Men who want to move bigger loads at lower cost will envision new opportunities to save with big, off-highway trailers. Easton will design and build these trailers.

Easton Car & Construction Company, Easton, Pa.

ALL TYPES OF HEAVY-DUTY INDUSTRIAL CARS • TRAILERS • TRUCK BODIES • ELECTRIC TRUCKS

Looking for Motors? Maybe We Can Help You!

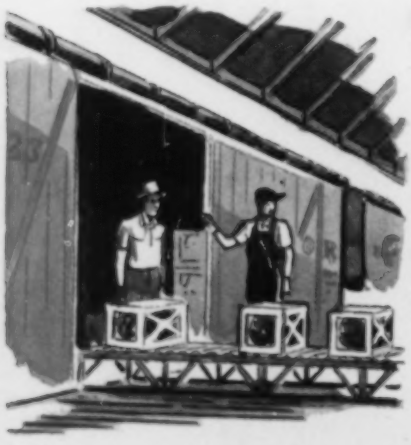
ALLIS-CHALMERS AUTHORIZED DEALER

ALLIS-CHALMERS REPRESENTATIVE

Do You Need General-Purpose, squirrel-cage motors from 1 to 200 hp? Get in touch with your nearby Allis-Chalmers *Authorized Dealer* or District Office. Either may be able to help you from stock right now!

But For Really Big Motors — 250 to 25,000 hp and over — call your Allis-Chalmers *field engineer*. He's an *expert* on motors—can help you solve difficult drive problems, involving large or small motors, in the most economical manner.

Want Reliable Information on motor delivery? Call *either* your Allis-Chalmers dealer or district office. They have *up-to-the-minute* delivery information available to them!



Motor "Headquarters"—½ to 25,000 hp and Up!

YOU SELECT from a *wide range* of motors when you call on Allis-Chalmers.

And you can count on *expert* motor advice, too! The best possible motor selection is the result of careful appraisal of drive characteristics, the driven equipment, power source and surroundings. The best motor may not always be the first that meets the requirements.

Allis-Chalmers authorized motor dealers or factory representatives can help you choose wisely. They can save you time and money. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 2401

The Delivery Picture's getting brighter! Our motor-building capacity has been greatly increased. We've put new methods, new equipment to work to turn out *more* motors for industry, faster!

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

Eimco FOLDING SCRAPER

Match these advantages against those listed for any other Scraper.

1. Positive control at all times. Opening and closing of scraper blades even on return.
2. Scraper rides over the muck going back. Does not pull muck back to the tail sheave.
3. Operates in flooding fingers. Will fold to half original height for narrow openings.
4. Low center of gravity decreases upsetting.
5. Free running at all times. Cannot get stuck behind muck pile if folded with cables.
6. Quick cable hitches reduces cable wear as much as 50% over same size scraper of other design using conventional hitch.
7. Lifts cables out of muck piles better than other scrapers.
8. Wider folding scrapers of this type can be operated in drifts. This action decreases choking of fingers.

Numerous other advantages are designed into the Eimco Folding Scraper. Write for more information.

EIMCO

THE EIMCO CORPORATION

Executive Offices and Factories: Salt Lake City 8, Utah: Branches — 67 Wall St., New York 5 — 3319 So. Wallace St., Chicago 16 — Mills Bldg., El Paso — 1217 - 7th St., Sacramento 14 Birmingham 9, Alabama — 110 Malaga 1055

Shell Incorporates Design Refinements In Fluid Catalytic Unit at Deer Park
L. S. DANIELS, Associate Editor
SHELL Oil Company's new "fluid" type catalytic cracking unit at its Deer Park (Houston) refinery incorporates much of the experience gained in the operation of earlier fluid units, as well as a number of newly developed design features undergoing initial commercial application. The unit is of special interest because it is the first large-scale plant placed in operation which has been designed for use with "micro-sphere" cracking catalyst. At present, results with this catalyst are not available as initial operations has been with ground catalyst. At present, result interest are refinements in the process design of th unit, and in the details of the process equipment instrument installation, piping design, equipment ment layout. Using pressure-drop data and equip previous units, and through careful design of the catalyst-circulation system, it has been possible to lower the elevation of the regenerator, and consiederably reduce the overall height of the unit.
The physical layout of the unit is noteworthy. Process equipment is provided with suitable access
Shake Structure
Regenerator has 9 short stacks through which flue gases are treated. Fractionating tower at left with catalyst slurry in front. The reactor is at left of regenerator. Reactor vapor line to fractionating tower has been made smaller by utilization of maximum practical pressure drop. Smaller line does not require complex bends for expansion
Equipment Support
Structure has three decks, with exchangers and coolers on highest level, reflux drums and other accumulators at mid-level, and pumps, blowers and compressors at grade level.
and

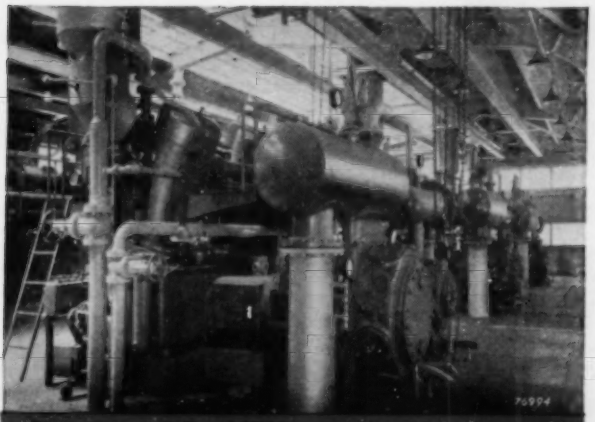
*Reprinted from
PETROLEUM REFINER,
February 1947

The 4-CYCLE V-ANGLE Line

INGERSOLL-RAND COMPANY, 11 BROADWAY, NEW YORK 4, N. Y.

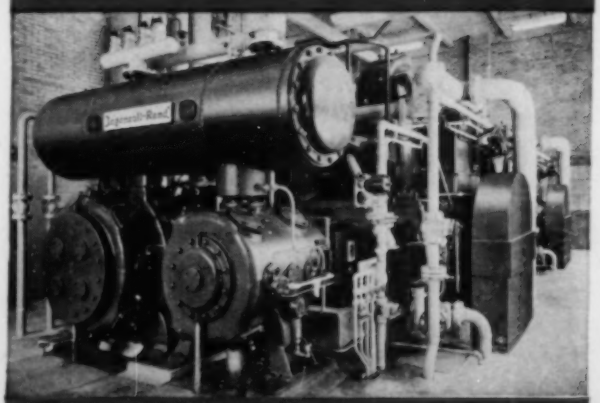
the compressors are 4-cycle, V-angle

Ingersoll-Rand



Seven Ingersoll-Rand KVG gas-engine-driven compressors (800 hp each) handling gas in the catalytic-cracking unit at Shell Oil Company's Deer Park, Texas, Refinery.

Another view of the same Ingersoll-Rand KVG compressors.



Two Ingersoll-Rand KVG's furnishing Air-Power for other processes in the same refinery.

The Shell Oil Company engineers had very good reasons for choosing Ingersoll-Rand Type KVG gas-engine-driven compressors for their "fluid" catalytic cracking unit at Deer Park, Texas.

They wanted dependable compressors that would stand up under continuous, full-load service... compressors with the versatility to handle surging, variable, or steady loads and pressures... compressors with the simplicity of design and economy of operation that keeps costs low.

These qualities are inherent in Ingersoll-Rand's *4-cycle, V-angle* design. For years KVG has been the symbol for the finest in gas-powered compressors... a reputation earned "on the job" in oil-field and refinery service all over the world.

A line of machinery... built with experience... serving all divisions of the petroleum industry.

COMPRESSORS
GAS & DIESEL ENGINES
PUMPS, VACUUM EQUIPMENT
AIR & ELECTRIC TOOLS

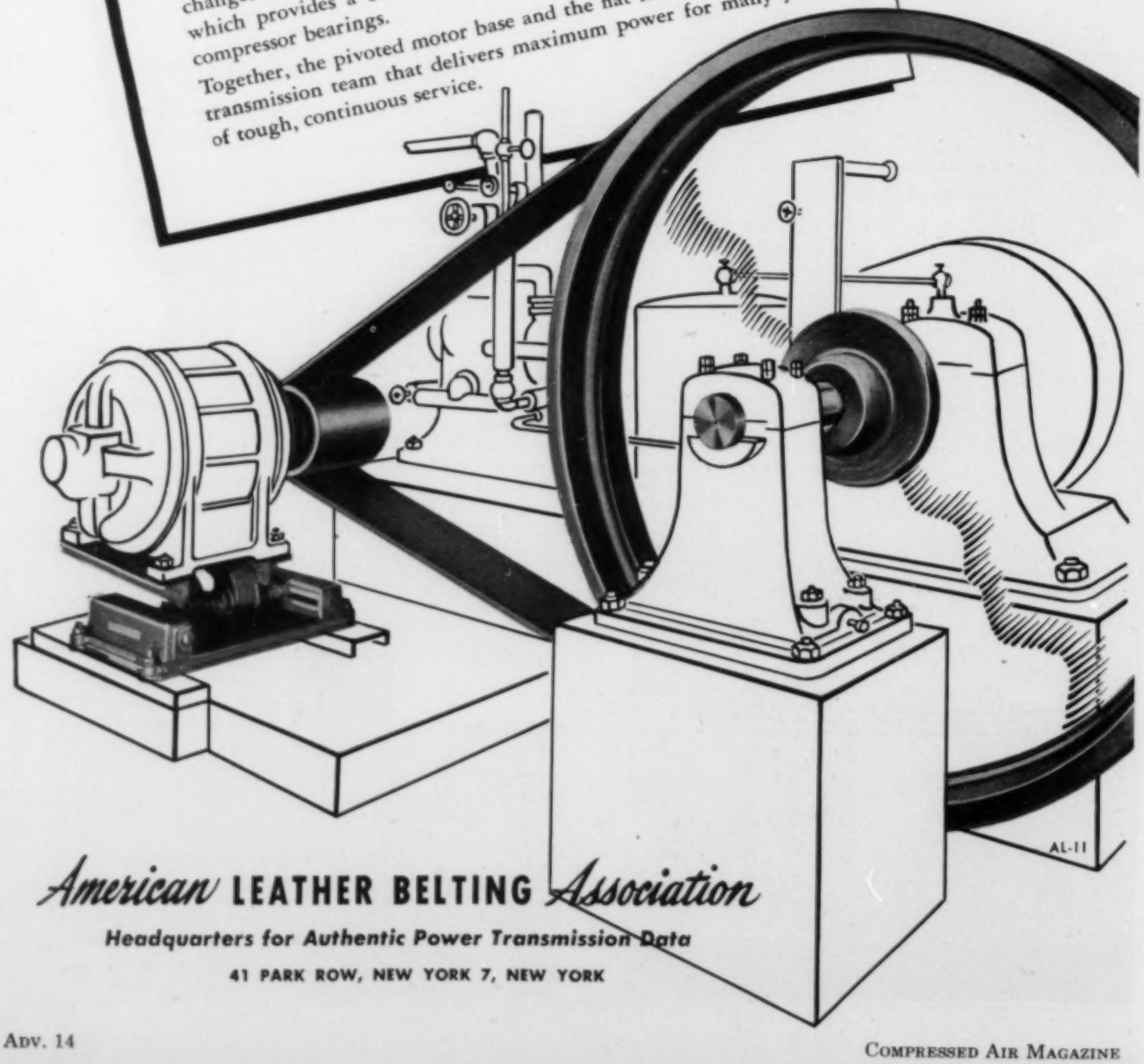
157-4

A compressor needs a drive that can soak up punishment

Thumbling

The heavy loads and starting conditions of compressor service demand a drive that can absorb punishment and come back for more. That's exactly what *first quality leather belt* plus a pivoted motor base can do. The base provides automatic, instantaneous compensation in belt tension for changes in load. The belt has a natural, self-adjusting resiliency which provides a cushioning effect, saving wear on motor and compressor bearings.

Together, the pivoted motor base and the flat leather belt make a transmission team that delivers maximum power for many years of tough, continuous service.



American **LEATHER BELTING** *Association*

Headquarters for Authentic Power Transmission Data

41 PARK ROW, NEW YORK 7, NEW YORK

Famous for Safety and Service . . .

*Securityflex** PARALLEL MINING CABLE

- Cuts Short Circuits
- Meets Pennsylvania Flame Test
- Withstands severe overloads
- Resists abrasion
- Will not kink, twist or tear
- Meets Bureau of Mines diameter specifications

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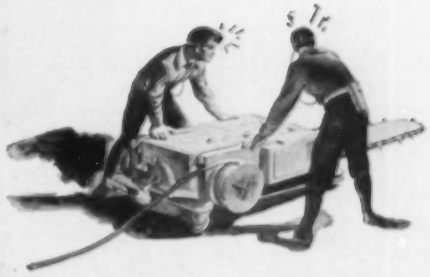


. . . Assures uninterrupted mine operation

*Reg. U. S. Pat. Off.

ANACONDA from mine to consumer

ANACONDA WIRE AND CABLE COMPANY

25 BROADWAY, NEW YORK 4, N. Y.

AVOID THE LUXURY TAX

on Idle Horsepower

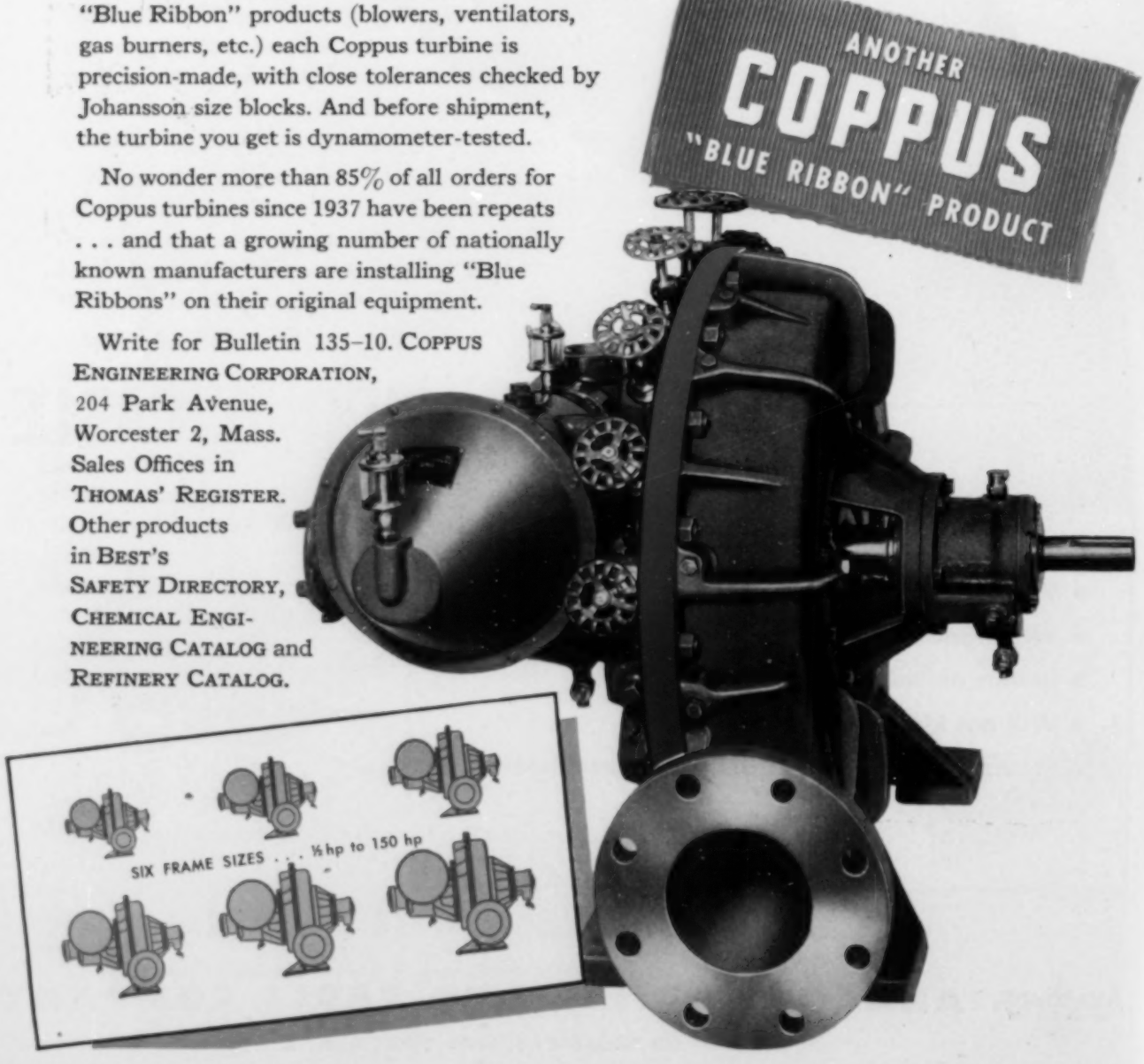
When your horsepower needs are small, why pay the extra cost of larger turbines, designed for much more power than you require?

You pay only for the horsepower you need when you fit the right Coppus "Blue Ribbon" Turbine to the load. They're made in six frame sizes . . . from 150 hp down to fractional . . . priced in proportion to their size.

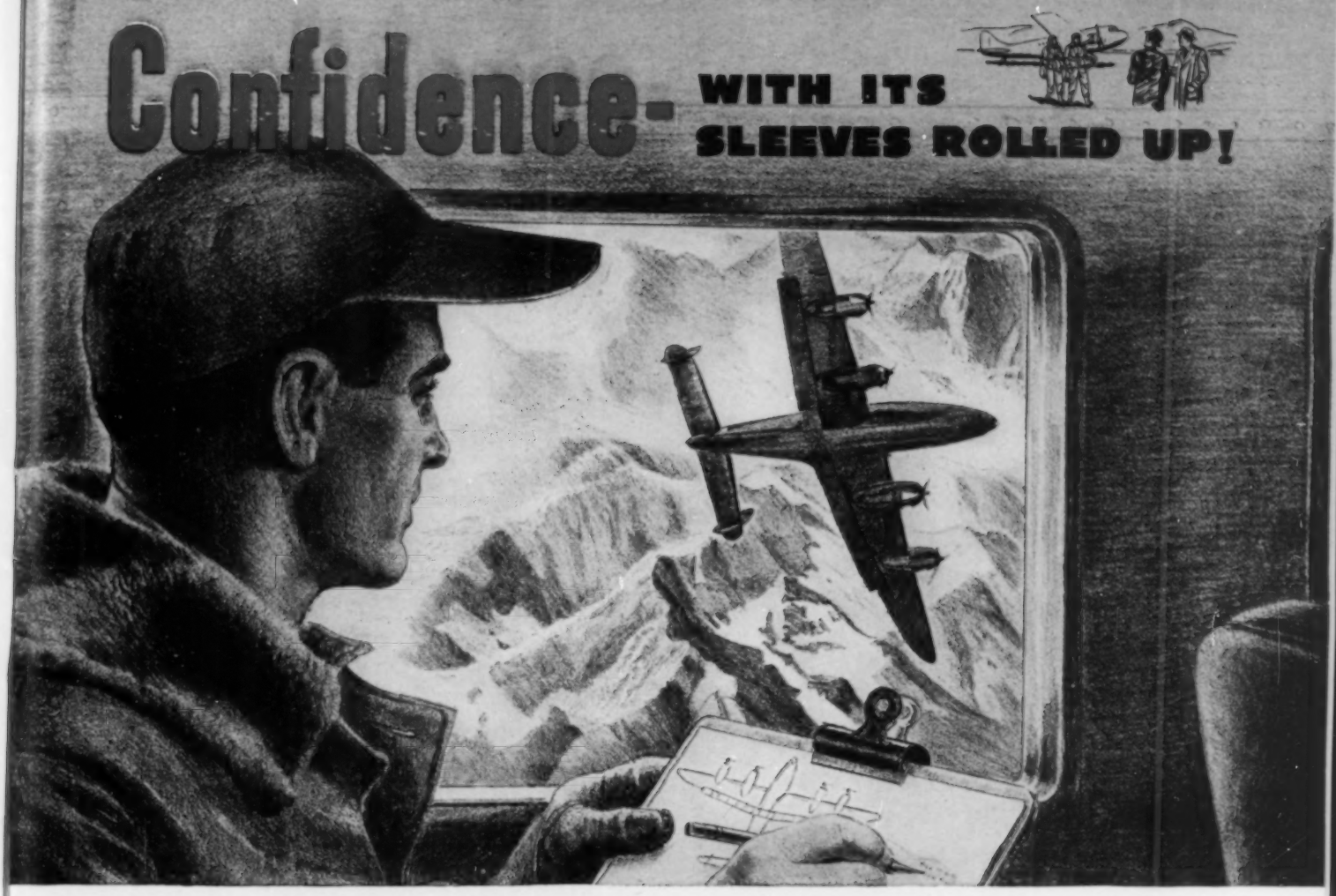
That's why you'll see more and more Coppus turbines powering pumps, blowers, fans, stokers and other equipment requiring a steady source of small hp. *Steady* is the word for these busy little turbines. Like all Coppus "Blue Ribbon" products (blowers, ventilators, gas burners, etc.) each Coppus turbine is precision-made, with close tolerances checked by Johansson size blocks. And before shipment, the turbine you get is dynamometer-tested.

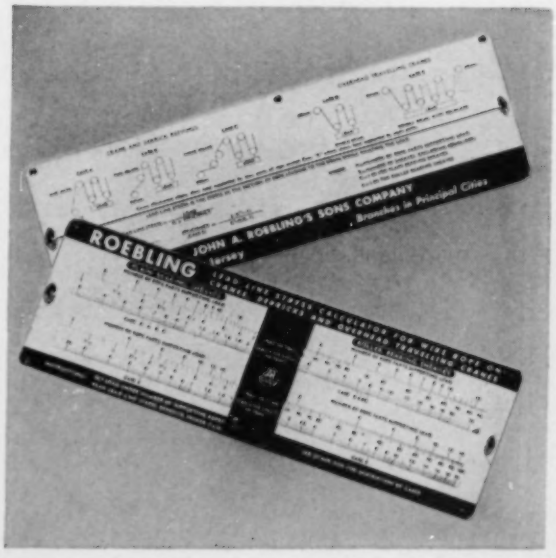
No wonder more than 85% of all orders for Coppus turbines since 1937 have been repeats . . . and that a growing number of nationally known manufacturers are installing "Blue Ribbons" on their original equipment.

Write for Bulletin 135–10. COPPUS ENGINEERING CORPORATION, 204 Park Avenue, Worcester 2, Mass. Sales Offices in THOMAS' REGISTER. Other products in BEST'S SAFETY DIRECTORY, CHEMICAL ENGINEERING CATALOG and REFINERY CATALOG.



Confidence- WITH ITS SLEEVES ROLLED UP!





YEAR BY YEAR, planes grow bigger . . . faster and safer. Man has unbounded confidence in his ability to build better and better planes. Never satisfied, he experiments and tests tirelessly, and aviation progresses.

With similar vision and confidence, Roebling has been pacemaker in the development and manufacture of products essential to the transportation and other industries. The active, widespread confidence it has won among technical men and operators throughout industry is Roebling's proudest asset. Look to Roebling for continued leadership . . . continual improvement in its products and engineering . . . continual progress.

WHAT SIZE OF ROPE? HERE'S YOUR ANSWER—FREE

DATA used by Roebling engineers themselves are embodied in this unique "slide rule". It's the Roebling Lead Line Stress Calculator for wire rope . . . tells you in a moment the safe and economical size of rope for every load . . . gives the right answer for all types of crane, derrick, and overhead traveling crane installations.

Here's information you can accept and act upon with complete confidence . . . just as you can specify Roebling "Blue Center" Steel Wire Rope for unsurpassed toughness, dependable reserve strength and the reduction of costly replacement shut-downs. Roebling was America's first wire rope maker, and "Blue Center" Steel Wire Rope is the finest that Roebling knows how to make.

Write for a Roebling Lead Line Stress Calculator — it's free. And let your Roebling Field Man tell you about installation and maintenance practices that prolong wire rope life. Call him at your nearest Roebling branch office.

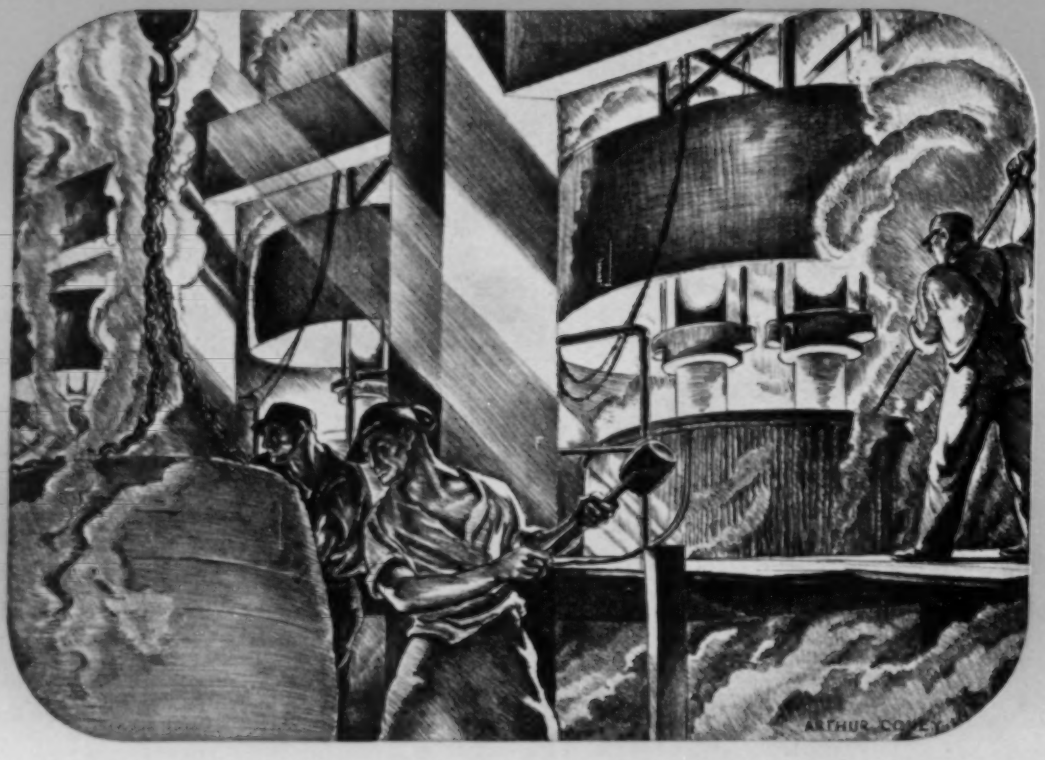
JOHN A. ROEBLING'S SONS COMPANY
TRENTON 2, NEW JERSEY
Branches and Warehouses in Principal Cities

A CENTURY OF CONFIDENCE **ROEBLING**

★ *WIRE ROPE AND STRAND* ★ *FITTINGS* ★ *SLINGS* ★ *SUSPENSION BRIDGES AND CABLES* ★ *AIRCORD, AIRCORD TERMINALS AND AIR CONTROLS* ★ *AERIAL WIRE ROPE SYSTEMS* ★ *ELECTRICAL WIRE AND CABLE* ★ *SKI LIFTS* ★ *HARD, ANNEALED OR TEMPERED HIGH AND LOW CARBON FINE AND SPECIALTY WIRE, FLAT WIRE, COLD ROLLED STRIP AND COLD ROLLED SPRING STEEL* ★ *SCREEN, HARDWARE AND INDUSTRIAL WIRE CLOTH* ★ *LAWN MOWERS*

Producing ALUNDUM®

the world's most widely used abrasive



IN these unique, arc-type furnaces at the Norton electric furnace plant near Niagara Falls is produced ALUNDUM abrasive — fused at 3700°F from mineral bauxite.

Introduced to industry by Norton in 1901 this first electric-furnace-made aluminum oxide abrasive revolutionized the grinding of steels because of its combination of hardness, sharpness and toughness.

Subsequent Norton developments were designated as 38 ALUNDUM and 57 ALUNDUM—and then in 1946 came the sensational 32 ALUNDUM abrasive.

Today ALUNDUM abrasive in its various forms is the world's most widely used abrasive.

NORTON ABRASIVES

NORTON COMPANY • WORCESTER 6, MASS.
(BEHR-MANNING, TROY, N. Y. IS A NORTON DIVISION)

ABRASIVES • GRINDING WHEELS • GRINDING AND LAPPING MACHINES • REFRACTORIES • POROUS MEDIUMS • NON-SLIP FLOORS NORBIDE PRODUCTS • LABELING MACHINES • (BEHR-MANNING DIVISION: COATED ABRASIVES AND SHARPENING STONES)

ON THE COVER

AFTER WINTER snows have partly melted and disappeared from mountainsides, the vestiges remaining in erosional depressions often take on meaningful configurations. Two of these manifestations are visible in Colorado each year and have religious significance. Best known is the Mount of the Holy Cross. The other one is the Angel of Shavano.

Legend has it that the angel, in punishment for her misdeeds, was sentenced by Jupiter to live on the side of Mt. Shavano until she should be moved to tears by the tragedies and sufferings of mankind. One year, when a drought threatened farm crops, she was overcome by sorrow and began to cry. As the tears flowed her body melted, and the water ran down onto the parched fields, making them green again. Then the angel was happy because she had saved her people. To this day the Angel of Shavano melts each spring to give life to the farm crops in the Arkansas Valley.

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IN THIS ISSUE

IN TIMES long forgotten, ancient peoples discovered the art of working and shaping iron. No doubt it was some inquisitive metalworker who first found that two pieces could be joined by heating them and hammering them together. The world's first welder, he would be astonished if he could see the magnitude of the industry today. The story of its growth is told in our first article.

•

AN INADEQUATE and unintegrated railway system has been one of the main stumbling blocks in South America's economic development. The recent conflict served to emphasize that need. Several of the republics are now taking steps to improve their rail systems. The handicaps they face and how they plan to overcome them are described on pages 85-88.

•

POWER plants often produce electricity with diesel-engine generators because they operate economically and require little installation space. Furthermore, they can be assembled at the factory and shipped complete, ready for service. An account of the part played by such a unit in quickly restoring a burned-out power plant starts on page 89.

•

HOBBIES bring relaxation and relief from the daily grind to countless persons and sometimes develop into profitable businesses. On pages 92-93 we tell about a young veteran who has turned such a pastime into a paying proposition.

Compressed Air Magazine

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VOLUME 53 **April, 1948** NUMBER 4

G. W. MORRISON, *Publisher*

C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Associate Editor* J. J. KATARBA, *Advertising Mgr.*
A. W. LOOMIS, *Assistant Editor* JOSEPH C. DILTS, *Advertising Sales*
WALTER P. GILLINGHAM, *Assistant Editor*
D. Y. MARSHALL, *Europe*, 243 Upper Thames St., London, E.C.4.
F. A. MCLEAN, *Canada*, New Birks Building, Montreal, Quebec.

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A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit

Published by Compressed Air Magazine Co., G. W. MORRISON, *President;* C. H. VIVIAN, *Vice-President;* J. W. YOUNG, *Secretary-Treasurer.*
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York 4, N. Y., L. H. GEYER, *Representative.*
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index.

The Story of Welding

W. P. Gillingham

PHOTO, BETTMANN ARCHIVE

SIR HUMPHREY DAVY

His discovery in 1801 of the electric arc led to the development of modern welding. A native of Cornwall, England, Davy showed no inclination towards science until he was apprenticed to a surgeon-apothecary at the age of 21, when he began experimenting with any apparatus that he could find. While on the staff of the Medical Pneumatic Institution at Bristol in 1799 he learned that nitrous oxide is respirable, reporting that he had become "absolutely intoxicated through breathing 16 quarts of it in seven minutes." His work there won him an appointment to the Royal Institution, where he was in charge of the laboratory and his assistant, for a time, was Michael Faraday. In 1815, Davy invented the miners' safety lamp that bears his name. He did not patent it, and in appreciation of his contribution the Newcastle coal-mine owners gave him a silver service in 1817. Under the terms of his will, the service was melted down and sold for about $3700 to endow a fund for a medal to be presented each year for the most important discovery in chemistry in Europe. Among the first to receive it was Robert W. von Bunsen, originator of the burner that is still used in chemical laboratories.

CREDIT for modern welding is generally given to Sir Humphrey Davy because his discovery of the electric arc in the first part of the nineteenth century led to the development of arc welding and to a new era in the art of joining metals. To most persons the term "welding" brings to mind the sputtering flame and bluish glare of the electric arc, for this young giant among the tools of industry has enjoyed such a phenomenal growth in the last three decades that it has overshadowed other processes. Yet arc welding is but one of many forms of welding which, itself, is so old that its roots are lost in antiquity.

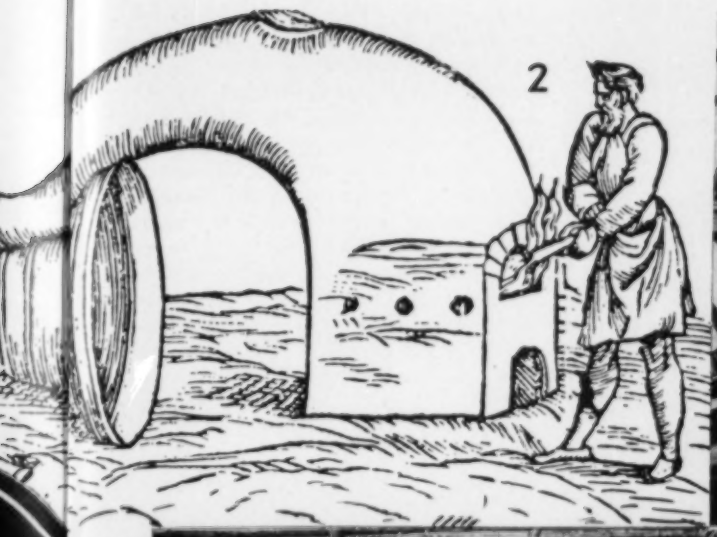
The story of welding is man's quest through the ages for new ways of utilizing the earth's resources for his own betterment. One of the oldest-known facts about the working of iron is that parts softened and rendered plastic by heating in a fire will, under suitable conditions, unite or "weld." Because few implements of iron or steel survive the attack of rust for many years, there remains little direct evidence as to just when welding originated. The art of working and hardening steel, an advanced stage in metalworking that it doubtless took centuries to reach, was commonly practiced 30 centuries ago in Greece and is mentioned by Homer. It is probable that the principles of welding were discovered, lost, and rediscovered repeatedly by ancient peoples the world over, for it has been proved that primitive tribes on different continents and with no apparent means of communication developed and used the same basic methods of smelting, shaping, and treating iron.

By the time of the Renaissance, welding with fire had become an established practice and the craftsmen of that period were highly skilled in the work. The parts to be joined were properly shaped and then reheated to the right temperature in a forge or furnace before being hammered, rolled, or pressed together. Vannoccio Biringuccio's *Pyrotechnia*, published in Venice in 1540, contains several references to such operations. In one case, a square piece of steel was welded to the end of an iron rod for use in turning cannon bores. In another, cracked bells were made whole again by a method of welding. It is obvious that Biringuccio was intrigued by the latter application, for he wrote, "This seems to me an ingenious thing, little used, but of great usefulness."

For many centuries thereafter, ordinary fire remained the principle source of heat for welding purposes. The traveling tinker, a familiar figure on the dusty roads of many a countryside, carried with him a small charcoal furnace for heating his irons. Tinsmiths and other workers in metal often fanned the flames to greater intensity by means of bellows or used the heat of burning gases to braze and solder.

Forge welding of iron developed into an industry of considerable proportions, and until about 1890 was the only method available for welding this metal. Great skill and much labor were required in joining large, heavy pieces, for they could be heated sufficiently only by maintaining a fire around them. When the two parts had reached the proper temperature, they were forced together by various means, often being hung from cranes to facilitate the operation. Then the ends were struck repeated blows with a sledge hammer for a definite period, the heat being kept up meanwhile. That done, the work was withdrawn from the fire and finished on an anvil. Forge welding is still practiced to some extent today, mainly in railroad and country blacksmith shops.

In 1801, while experimenting with the infant science of electricity, Sir Humphrey Davy discovered that an arc could be created between two terminals of an electric circuit of comparatively high voltage by bringing them near each other. This arc, which cast a bright light and gave off a considerable amount of heat, could be struck and maintained at will, and its length and intensity could be



PHOTOS, BETTMANN ARCHIVE

BEGINNINGS OF WELDING

1– Long before the Christian era, blacksmiths joined metals by pounding them after they had been heated to a plastic state. 2– This apparatus, shown in Biringuccio's "Pyrotechnia" published in 1530, served to heat a cracked bell preparatory to forge-welding it. 3– An 1840 woodcut of a welding shop using lead and a hydrogen lamp for heating. 4– Elihu Thomson, American inventor, in the electrical workshop where he developed resistance welding, which was introduced in 1896.

varied within limits determined by the type of terminals utilized and by the circuit voltage. At that time it was regarded as a curiosity—there was no practical use for it. In fact, Sir Humphrey did not apply the name "arc" to his discovery until twenty years later.

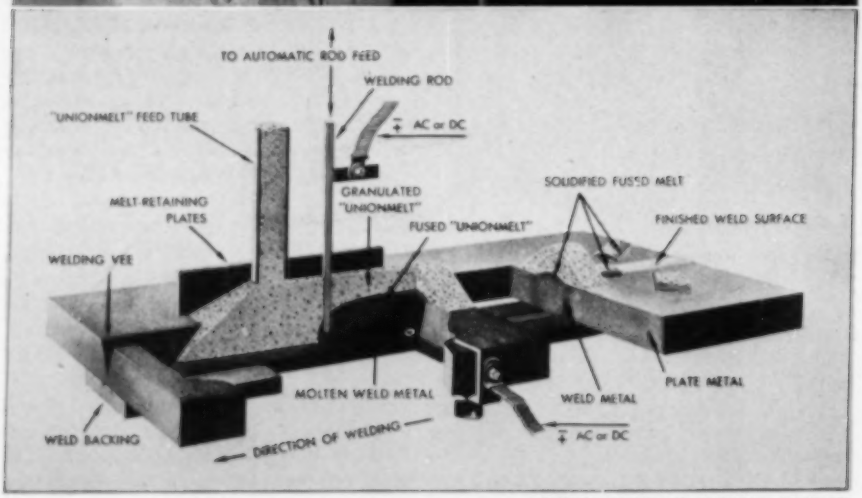
The electric arc remained a scientific plaything until 1881, when the well-known carbon-arc street lamp was introduced. Shortly thereafter the electric furnace made its appearance, one of the earliest being installed in 1886 at Milton Staffordshire by the Cowles Brothers for the production of aluminum alloys, the heat of a carbon arc serving to reduce alumina in the presence of iron or other metals. This particular application of the electric arc was an important step in the early history of the metal aluminum, for it disproved the belief, expressed by Lavoisier as far back as 1782, that the compound alumina could not be reduced by the element carbon.

Probably the first attempt to use the intense heat of the carbon arc for welding purposes was made in 1881 when De Meritens, an inventor, joined parts of a storage-battery plate by that process. In his experiment, he connected the work to the positive pole of a source of current and attached the carbon rod to the other pole in such a way that its distance from the plate could be controlled by the operator. The heat induced was partly lost in the surrounding air, but enough reached the plate to fuse the metallic lead and unite the several parts. In other early efforts with two carbon electrodes spaced as in an arc lamp and connected to a source of current, the heat of the resultant arc was deflected against the work by means of magnetic currents or a jet of compressed air.

Guided by these early experiments, M. V. Bernardos, a Russian scientist, reversed the procedure by connecting the work to the negative pole of a direct-current circuit and fastening the carbon rod to the positive pole, the arc being drawn between them. The rod was not fixed as in De Meritens's method, but was fitted with an insulated handle so that it could be manipulated by hand. This process, which was patented in 1887, had the disadvantage of introducing particles of carbon into the metal, making it hard and brittle. In the Slavienoff system, announced two years later, the carbon electrode was replaced by a metal rod which, upon striking an arc, gradually melted and added fused drops of metal to the weld.

Although the pioneer commercial application of arc welding in the United States is believed to have been made in 1910, its proponents were too far ahead of their time. The first motor-generator sets especially designed for arc welding were brought from Europe, where the process was in a more advanced stage. The sponsors of these machines induced a manufacturer to build them in this country, but the project was financially unsuccessful because the general public was not acquainted with arc welding and, consequently, skeptical as to the claims made for it. Further hindrances to its acceptance were the bulkiness and inflexibility of the existing equipment and the fact that no attempts were being made to develop suitable electrodes.

Arc welding received the needed impetus when emergency conditions during World War I brought it into the limelight. The U. S. Navy became interested when the method was successfully employed on interned German ships to salvage engines and other machinery that the crews had wrecked. All the welding during that period was done with hard metal rods of the fence-wire variety, so that the results, while spectacular in comparison with earlier ones, left much



PHOTOS, LINDE AIR PRODUCTS COMPANY

SUBMERGED-MELT WELDING

In this form of shielded-arc welding, a finely granulated material, which goes under the trade name Unionmelt, entirely submerges the tip of the welding rod, the arc, and the resultant weld (lower view). Even when brought to the temperature of the welding zone, the powder gives off only a minute amount of gas. It is a nonconductor of electricity when cold, but in the molten state will allow passage of sufficient current to make the weld. Fusion is started by placing a small wad of steel wool between the end of the welding rod and the work, then turning on the current. The heat generated melts the powder, which flows freely along the seam and forms a protective cover under which the welding operation takes place without sparks, spatter, fumes, or flash. The molten material forms a slag that floats on top of the base metal and insulates it from the atmosphere while it is cooling. Because of its nature in the fused state, the powder permits the use of high-current densities, with the resultant liberation of intense heat; and also because it concentrates the heat in a relatively small weld area, high welding speeds can be obtained with unusually deep penetration into the base metal. For these reasons the process lends itself to the automatic welding of heavy steel plate and was widely used during the war in shipyards for welding deck seams and for other fabricating work. The upper view shows a submerged-melt welding machine making a girth weld to join sections of 32-inch-diameter pipe for a natural-gas line. The pipe is rotated clockwise as operations proceed, and the Unionmelt is fed from an overhead hopper. A pneumatic collector serves to retrieve unfused granules and carries them to a storage bin for reuse, while a workman equipped with a hand tool removes the slag formed by the powder as it melts.

to be desired. Therefore, when coated electrodes were imported from Europe, they aroused considerable attention but did not at once attain widespread popularity. Though they did better work than bare wire, they were too expensive for ordinary use because the coating was applied by hand winding and dipping. Experiments conducted in this country with a view towards developing lower-cost methods were successful, and by 1930 facilities were available for the mass production of electrodes of this type. The U. S. Navy, which had contributed much to the growth of the struggling industry, then revised its specifications for welding machines from 25 to 40 volts in order to take full advantage of the shielded arc formed by the coated electrodes.

Another event that occurred about that time gave arc welding international publicity. By the Treaty of Versailles, the size of Germany's new ships was restricted to 10,000 tons. When she brought out the first in a line of "pocket battleships," which displaced only 10,000 tons but mounted guns of a caliber equal to that of much larger vessels, the world naturally sat up and took notice. By resorting to all-welded construction, the Germans were able to save weight and thus equip the craft with heavier armor and more guns without exceeding the over-all weight limit.

Aided by the aforementioned developments and encouraged by industry's need of rapid and economical methods of fabricating objects from metal, arc welding entered upon a period of growth that was truly remarkable. Its wide application gave birth to many new things and industries that otherwise might not have been created. Today there is hardly a plant in the country that does not use either arc welding or its products, and new applications for the process are continually being discovered. It is finding increasing usefulness in heavy construction work such as the erection of bridges and large buildings.

Although many of us are familiar with the method of arc welding, scientists are still trying to fathom the secret of the phenomenon of the electric arc. What it does is well known, for its temperature—with an estimated range from 6000 to 11,000°F.—brings the work to the melting point almost instantaneously, making possible deep, clean, and rapid welds. Electrodes may be composed of carbon, bare metal, or coated metal, but the latter type is used well-nigh universally.

Welding with the carbon electrode is a puddling process; that is, the arc serves to melt the work until there is a small puddle of molten metal which grows to a size sufficient to make the weld. Because of this, the method is not suitable for overhead welding, and its greatest application is in the field of automatic welding. It may be used with economy

OXYACETYLENE WELDING AND CUTTING

The combustion of acetylene gas and pure oxygen, which are thoroughly mixed at the blowpipe nozzle (left), produces a temperature that is estimated to reach up to 5400°F. Substitution of other gases for oxygen results in lower temperatures and, consequently, great flexibility that makes the process suitable for welding various metals. Fusion is usually, but not always, caused by flowing metal from a welding rod into the opening between the parts to be joined. In addition to welding, the oxyacetylene torch is widely used for the speedy cutting of metals (below).

PHOTOS, LINDE AIR PRODUCTS COMPANY

PHOTO, GENERAL ELECTRIC COMPANY

ATOMIC-HYDROGEN WELDING

Two tungsten electrodes are being used here to maintain an arc in the midst of a stream of hydrogen gas. Hydrogen is diatomic in its natural state, having two atoms in each molecule. When the gas passes through the arc, much of it is dissociated, and in so doing absorbs a considerable amount of energy. In striking the work to be welded, the atoms recombine into molecules and release their captive energy as heat. The temperature obtainable by this method is around 6000°F. and results in uniform, ductile, and unusually smooth welds. The picture shows a filler rod being held in the arc flame to provide metal for facing gear teeth.

as a cutting tool in dismantling assemblies. Overhead welding can be done by replacing the carbon electrode with a metallic rod, for in this case the transfer of metal from the rod to the work is not dependent upon gravity. Tiny globules of molten metal form on the tip of the electrode and are carried across the arc to the work by molecular attraction, adhesion, cohesion, or a combination of these forces.

In the ordinary arc struck with a metallic electrode, the globules which flow from the electrode, as well as the fused area of the work, are exposed to the atmosphere. Molten steel has an affinity for oxygen and nitrogen, both of which are found in abundance in the atmosphere, and will combine with them to form oxides and nitrides which weaken and embrittle the metal and lessen its resistance to corrosion. An ideal weld, one whose properties are equal to or better than those of the parts to be joined, cannot be made by arc welding unless the metal is protected from the harmful effects of the atmosphere during the entire operation from liquefaction to solidification.

In order to obtain a joint that is as nearly perfect as possible, most metallic arc welding is now done with what is called the "shielded" arc. The metal electrode has a chemical coating which disintegrates in the heat of the arc to create a cloud of protective gas that envelopes both the arc and the molten metal, shielding them from contact with the atmosphere. In addition to the gas, the coating forms a slag that floats on top of the molten weld metal and insulates it from the air while it is cooling. This slag, which is caused by the melting and reaction of the less-volatile mineral ingredients of the coating, also acts as a scavenger in that it removes oxides and other impurities from the metal, thus increasing its fluidity and helping to produce a better weld.

Since the coatings generally are poor conductors of electricity, the electrodes may be inserted into narrow grooves or other close quarters without danger of a short circuit by contact with the work. The coating also is an excellent medium for introducing alloying elements of different kinds into the weld metal to increase its tensile strength, hardness, and resistance to corrosion, or to give it other physical properties.

Commercial coatings usually contain compounds of substances such as silicon, barium, calcium, and magnesium. Metallic deoxidizers are sometimes added to get rid of small quantities of oxygen that may be in the weld metal, to control the amounts of the alloying elements, and to compensate for oxygen liberated from certain constituents in the coating. Water glass, a solution of sodium silicates, is commonly used as a binder, but

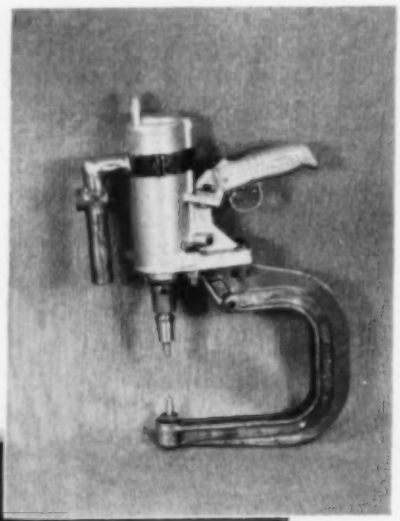
gums, glues, lacquers etc., may be employed. Another advantage claimed for the coated electrode is that the covering burns at a slower rate than the metal core, thus forming a sheath that extends for a short distance beyond the metal and serves to confine the arc flame and to focus it upon the work.

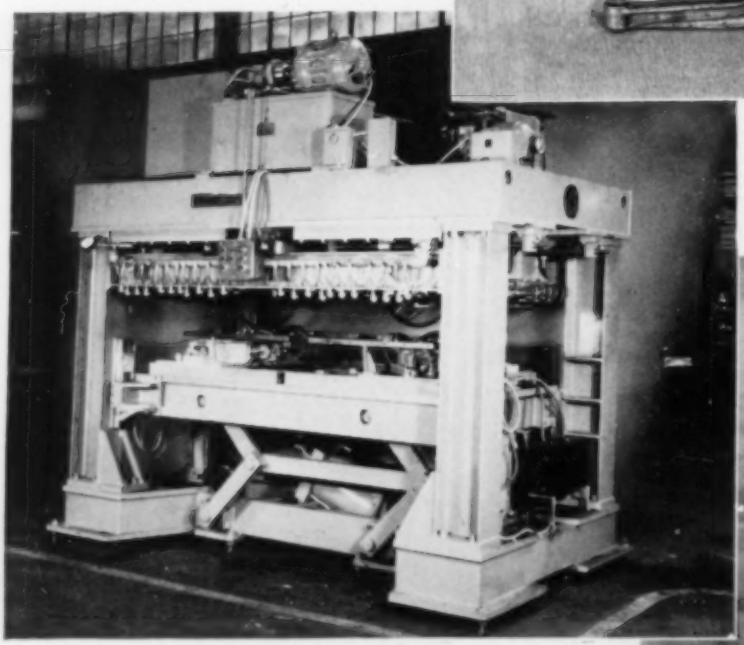
Another welding tool of more recent origin than the arc is the oxyacetylene torch which owes its origin to the discovery of a French chemist, Le Chatelier, in 1895. In a paper read before the Academie des Sciences, Le Chatelier disclosed that the combustion of acetylene with oxygen produces a flame having a temperature in the neighborhood of 6000°F., or far hotter than that of any other known gas flame. Well-nigh simultaneously with this discovery, work was being completed on two other processes that were destined to make possible the oxyacetylene-welding industry.

Acetylene is a colorless, combustible gas which forms an explosive mixture with air or oxygen. It is a product of the reaction between calcium carbide and water, the same on which the headlamps of early automobiles and present-day miners' carbide lamps are based. Calcium carbide was known as early as 1836, but was not produced commercially until 1892 when two men—Henri Moissan and T. L. Wilson, a Canadian electrical engineer—made it in Paris, France, and at an aluminum works near Leaksville, N. C., respectively, by heating a mixture of lime and anthracite in an electric furnace. In 1895, Dr. Carl von Linde of Germany placed a machine in operation for the manufacture of liquid air from which oxygen for industrial purposes is obtained. These two inventions—the use of the extremely high temperature of the electric furnace to produce calcium carbide, and the making of liquid oxygen at almost unbelievably low temperature—laid the foundation for the oxyacetylene process widely utilized today for joining, treating, and cutting metals.

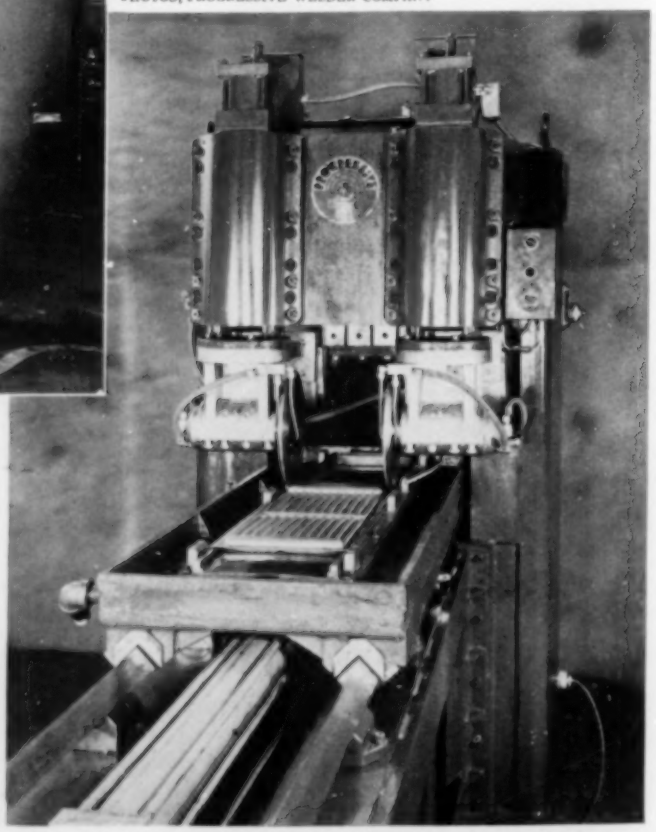
In the early stages of the method's development, many investigators experimented with blowpipes to control the oxyacetylene flame. That tool was by no means new to the metalworker, for a crude form of it had served ancient Egyptians, Greeks, and Romans in working metals possessing low melting points. In 1901, the first blowpipes capable of controlling the high temperature of the oxyacetylene flame were introduced by Fouche and Picard, with the result that the process was applied industrially by 1903.

By 1904, United States plants were turning out enough calcium carbide to meet the acetylene requirements of the nation. After much experimentation, a safe method of transporting the gas was devised. A porous material was packed tight in a steel cylinder and then saturated with acetone, a liquid having the property of dissolving many times its own volume of acetylene. Meanwhile, the oxygen supply in this country had been limited to the amount that could be produced by large-scale laboratory methods. In 1907, the first domestic





PHOTOS, PROGRESSIVE WELDER COMPANY



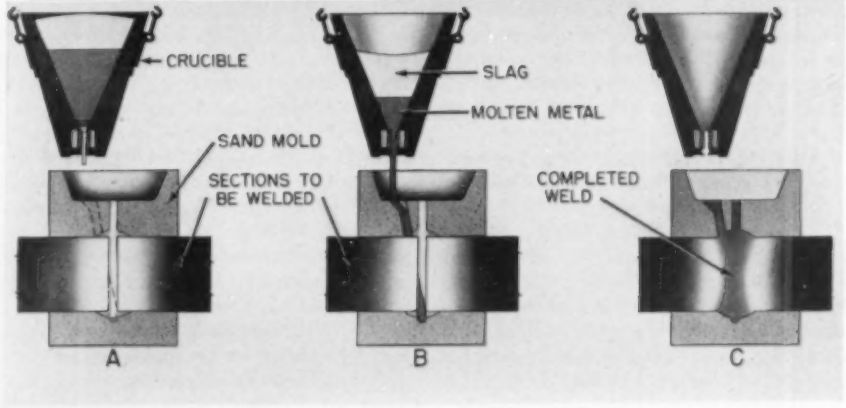
RESISTANCE WELDING

This process is principally used for joining relatively thin sections of metal by means of seams or numerous local welds. The welding areas are heated to a plastic state by passing an electric current through them and simultaneously exerting pressure to effect fusion. In the form of "spot "welding, it serves extensively in the mass production of various articles by means of special automatic machines. The view at the right shows a duplex seam welder designed for assembling stainless-steel trays for refrigerators. An air cylinder holds the electrode wheels on the work, while another moves the table on which the work rests. A multiple spot-welding machine that makes several dozen welds in rapid sequence on trailer door frames is pictured above. The table that carries the door is lifted into welding position by a 10-inch pneumatic cylinder acting through toggle linkage. Four other air cylinders bring the electrodes down in contact with the work. A portable spot-welding gun, with a built-in air cylinder that applies pressure to the electrodes, is illustrated at the top.

THERMIT WELDING

This process makes use of the intense heat generated by igniting a basic mixture of finely divided iron oxide and aluminum. The sequence of operations is shown at the bottom: A, the melting reaction, which is completed in about 30 seconds and takes place in an overhead crucible, produces molten metal and slag; B, upon tapping the crucible the contents flow into a prepared mold enclosing the parts to be joined; C, the result is a homogeneous weld. By adding varying amounts of carbon and manganese and occasionally nickel, chromium, vanadium, or other elements to the original mix, a wide range of alloys is obtainable. The view directly below shows a set-up for Thermit welding street-car rails. Equipment includes a crucible, a unit for preheating the rail ends on either side of the joint, tanks of oxygen and acetylene for use in cutting off metal risers left on the weld, tools for smoothing weld surfaces, and molds to be placed around the rail ends to receive the molten metal. A crucible discharging its molten mass into a mold is seen at the left.

PHOTOS, METAL AND THERMIT CORPORATION



plant for the manufacture of oxygen by the liquid-air process was placed in operation, and others followed rapidly as the demand increased. A few years before the outbreak of World War I, the distribution of oxygen and acetylene had become nationwide, and quantity production of welding and cutting blowpipes was underway.

Oxyacetylene welding possesses an advantage over arc welding in that it is extremely flexible. Although oxygen and acetylene are used well-nigh universally for the purpose, other combinations such as air and acetylene, oxygen and hydrogen, or oxygen and any other combustible gas are suitable. A mixture of air and acetylene serves where a lower-flame temperature is desired. The process usually necessitates the addition of a filler metal in the form of a rod held in the flame. Because the latter metal and the source of heat are separate from the work, better control can be exercised over the puddle. Protection of the molten metal from the atmosphere is provided by the enveloping flame. By applying a separate stream of oxygen, which is turned on after the work has been sufficiently heated, the oxyacetylene flame may be used for cutting.

Thermit welding was among the first of the new metal-joining processes to be developed. It is the invention of C. Vautin, who, in 1894, found that finely powdered aluminum mixed with metallic oxides, sulphides, and chlorides and then ignited would give a temperature of approximately 5000°F. and at the same time reduce the oxides to molten metal of a high degree of purity. Dr. Hans Goldschmidt of Essen, Germany, made a practical application of Vautin's discovery by using the molten metal produced by the reaction to weld together two iron bars. He also devised a safe method of igniting the mixture, on which he was granted a patent in 1897.

Welding by the Thermit process involves pouring superheated liquid steel around the parts to be united. Thermit, a mixture of iron oxide and metallic aluminum, is placed in a refractory-lined crucible and lighted with the aid of a highly inflammable powder composed largely of barium peroxide. During the resultant reaction, which is completed in about 30 seconds, the aluminum combines with the oxygen of the iron oxide

AIR-OPERATED TOOLS

Pneumatic tools are a necessary part of welding equipment. Most welders have, close at hand, a scaling hammer for use in cleaning welds and in removing slag and excess spatter (left). A chipping hammer (center) is an essential tool in preparing the welding Vee between two pieces of metal to be joined, in getting rid of unfused metal from the reverse side of an initial weld before starting the backing weld, and in removing excess weld metal flush with the surface. Portable grinders, equipped with either a wire brush or an abrasive wheel, serve to smooth the rough surfaces of welds and to get them ready for painting (right). Air-operated hoists are frequently utilized to expedite the handling of work, especially where heavy pieces are welded on a production-line scale.

to produce a slag, leaving pure molten iron. Elements such as carbon, manganese, silicon, sulphur, and phosphorus are usually added to convert the iron into a steel possessing physical properties similar to those of forged steel. Following the reaction, the molten Thermit steel is tapped into a sand-filled mold surrounding the parts to be joined. Since the metal is approximately twice as hot as ordinary molten steel, it fuses and welds the pieces into a single, homogeneous part. To prevent chilling of the steel, the work is heated before the molten metal is poured into the mold

The Thermit process is especially applicable to the welding of large sections and to the repair of heavy parts such as locomotive frames, rudders and stemposts of ships, crankshafts, railroad rails, spokes of driving wheels, motor casings, and connecting rods. One of its great advantages is that broken pieces can generally be welded without a change in position. The method is also used extensively in welding pipes, but in that case the technique differs slightly from that just described. Because the metal would fill up the pipe openings if it were allowed to come in direct contact with the piping, the crucible is decanted so that the slag enters the mold first, coating the outside of the pipes and the inside of the mold. When the liquid steel flows into the mold, it heats the ends of the pipes but is prevented from fusing with the metal by the slag coating. The sections are then forced together to form the weld.

With resistance welding, developed in 1896, Elihu Thomson gave industry a method that is not only simpler and less expensive than previous ones but that is applicable to a wider range of metals. An American inventor, Thomson was particularly active in the field of electricity, holding more than 700 patents and being one of the founders of the General Electric Company. His process is based on the fact that the resistance offered by a metal object to the passage of an electric current will generate heat within that object. Therefore, when two pieces of metal are brought in contact and current is passed through them they will be heated sufficiently to weld when pressed together. The acceptance of resistance welding by industry was immediate, one of its earliest uses being the welding of metal tires for wooden wagon and buggy wheels.

The process differs from others principally in that no foreign material is introduced into the weld. Metal parts that it would be difficult to bind together by other methods are easily resistance-welded, examples being fine wires or thin sheets. Ferrous and nonferrous alloys are welded with equal ease, and even totally different materials such as copper and steel can be joined. Because the process lends itself readily to automatic control, it is especially applicable to modern mass-production methods. It has a wide field of service in the manufacture of all kinds of products such as the household refrigerator, which has more than 3000 spot welds. Another large user of resistance welding is the automobile industry where, in addition to other types of welding, it finds large-scale application in fashioning automobile bodies.

Compressed air plays a vital part in welding. This applies especially to arc welding that calls for the services of literally thousands of air-operated tools in the fabrication of all sorts of metal objects. Pneumatic chipping hammers prepare the V-cut required in joining metal plates; gouge out unfused metal from the reverse side of a weld preparatory to making a backing weld; and remove excess metal from the surface of a finished weld. Air-operated grinders and scale removers help to clean and smooth welds for painting. Large welded objects are sometimes cleaned by exposing them to a blast of sand and compressed air. In arc welding cast iron, a jet of compressed air is directed upon the finished weld after it has been allowed to cool for a few seconds. By thus hastening cooling, the over-all welding time is reduced, it is claimed, by at least 25 percent.

Automatic welding machines are equipped with power cylinders largely of the pneumatic type that may be controlled by foot pedal to leave the operator's hands free for other tasks. These cylinders are used for a variety of purposes, one of them being the lowering and raising of the entire welding head of an automatic arc-type unit to permit placing and removal of the work. Many resistance-welding machines have such cylinders to clamp and hold the parts to be joined, while air-operated tables permit the continuous welding of long pieces or sheets of metal.

South America's Railroads Eye the Future

*Seymour T. R. Abt**

EWING GALLOWAY PHOTOS

SAO PAULO RAILWAY

A 10-year railroad rehabilitation plan, calling for expenditures of nearly half a billion dollars, was initiated by Brazil in 1946 but is not proceeding at the scheduled pace. The principal need is for continuous lines running north and south. One of Brazil's best railways is the Sao Paulo system extending into the interior from Sao Paulo. It was financed largely with revenue from the coffee industry. The road climbs 3000 feet in 25 miles, reaching its highest point at Alto da Serra. The station located there is pictured directly above. The other view shows a passenger train on the line.

SOUTH AMERICA'S railways are far from adequate to meet the demands of the continent's economy. Lines are run down, equipment is antiquated, and many areas are untapped by either rails or modern motor highways. Yet no one is more aware of their railways' shortcomings than the South Americans themselves.

Probably not until the recent conflict, when the Allies badly needed the continent's hidden wealth of precious raw materials, did South America realize its own economic strength. At the same time, exports of transportation equipment and other goods from the United States, Canada, and western Europe virtually ceased. The war made it clear, perhaps more than ever before, that South America would remain largely undeveloped so long as transport facilities were inadequate. Today there are fertile agricultural lands that are not worked because their produce cannot be moved to consuming centers. Mines cannot get their ores to smelters or to the seaboard for export. Valuable timber stands untouched in inaccessible forests. Pack trails are the only contact between countless isolated communities and western civilization.

Factors that have impeded the development of a continental rail network are too many and too complex for more than mere mention here. Enervating temperatures, torrential rains, rugged topography, disease-ridden swamps, and a lack of indigenous coal are among the natural difficulties. Many lines were originally built with foreign capital for private interests and without thought of eventual connection with other roads. There is no uniformity in gauge, virtually no railway-equipment industry. The competing motor highways were born before railroads had attained maturity.

A survey of recent railway expansion reveals definite trends. Foremost among these is a move towards nationalization. Though Argentina, which has nationalized substantially its entire system, is the outstanding example, there is not a republic in South America without some state ownership of railroads. The general feeling seems to be that the only way to make them function in the public interest is to bring them under government ownership. Private lines, especially those under foreign control, are rapidly losing out.

There is an emerging pattern of international railways. Advocates of hemispheric solidarity can find no more heartening development than this desire of neighboring countries to connect by rail. The transcontinental line from Santos, Brazil, to Arica, Chile, is foremost among these projects, but there are other significant ones.

Within national boundaries there is a determination to round out fragmentary networks. This is a slow and expensive procedure. Many railways are isolated and not part of any system. The stated objective of many governments, however, is the integration of such roads into coherent networks. Among these nations are Brazil, Colombia, and Venezuela.

Important as these trends are, South America's primary consideration is the rehabilitation of existing lines. The tremendous traffic increases of the war years, coupled with neglected maintenance through lack of imports, have created intolerable conditions in many areas. Deterioration of roadbeds and rolling stock is apparent everywhere. Most current railroad expenditures are allocated to repair and replacement of facilities rather than to expansion. The larger plans, vital as they are, are of secondary import.

Argentina has virtually finished taking over British- and French-owned railways, which accounted for nearly 70 percent of the total mileage. Their acquisition was one phase of a nationalistic policy to make Argentina a leading power in world economy. The Five-Year Plan for the period 1947-51 includes a tentative railroad program calling for the completion of a few lines now underway, the initiation of one or two new projects,

*Transportation and Communications Division, Office of International Trade, U. S. Department of Commerce.

and the purchase and modernization of equipment.

The existing network fans out of Buenos Aires and long since reached the country's main production and population centers. Revitalization of the system is more important to Argentina than new construction. The Five-Year Plan involves an outlay of about $195,000,000, most of which will probably be spent in purchasing badly needed rolling stock and bringing existing equipment up to date. The requirements, following eight years of deferred maintenance, are huge. In December, 1946, the government called for bids on 350 freight cars, and in the succeeding month placed orders for 210 diesel-electric locomotives. In July, 1947, bids were asked on 2500 railway cars, as well as on radio devices for car-to-car and car-to-station communication. Reports from various sources indicate that considerable additional equipment has been bought, ordered, or sought in recent months.

It is generally recognized that Brazil's inadequate transportation system is blocking full economic development of that country. Its vast area demands efficient railways, and Brazilians have long been acutely conscious of this need. In January, 1946, the Brazilian Government announced a $490,000,000 Ten-Year Plan of railroad rehabilitation. The Director of the National Department of Railways indicated that credits would be sought from the United States for the eventual purchase of 17,508 railway cars, 974 locomotives, the reëquipment of repair shops, rail renewals for 8615 miles of track, and the construction of 9615 miles of permanent way. It is difficult to estimate how much of this program will ever advance beyond the paper stage, but signs are not encouraging. Credits actually authorized by the Export-Import Bank during 1946 and the first half of 1947 total only $20,735,521.

Brazil's major railroad project is designed to give continuous, meter-gauge transportation from north to south within a relatively few miles of the seaboard. Lines running inland from various seaports dot the coastal region. However, except for those in the vicinity of Rio de Janeiro and Sao Paulo, most of them do not penetrate far inland and are not connected with other railways.

Other plans to improve or speed up the republic's rail service have been made or acted upon. Several systems have ordered new equipment in the United States, or are seeking credits for such purchases. Six of them have appropriated close to $750,000 for that purpose in the 1947 federal budget, the largest sum being $213,600 for machinery for the Curitiba shops of the Parana-Santa Catarina Railroad. In addition, $240,300 has been earmarked for rolling stock and for equipment needed in the building of passenger and "open cars" by the Braganca Railway.

Perhaps the most publicized of all the Brazilian rail projects is one that is being carried out in a neighboring country. This line extends from the Brazilian border across the little-known eastern part of Bolivia to Santa Cruz. The 1947 budget allocated $2,563,000 for the work which, when concluded, will provide through service between Santos and Arica. As this road is already operating between Santos and a point close to the Bolivian boundary, little new construction is necessary on Brazilian soil.

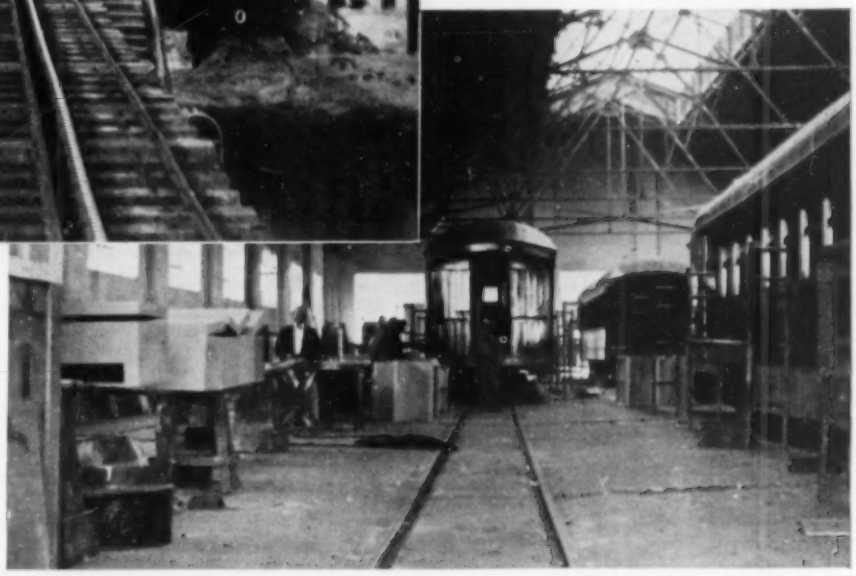
Completion of the Bolivian section of the line is still many years away. Its backers hope that it will foster trade between Bolivia and Brazil, afford a new sea outlet for Bolivia's mineral exports via the port of Santos, and facilitate the colonization, exploration, and development of the vast reaches east of the Antiplano. The last consideration is of primary importance to both countries because the region that would be served by the railway is believed to be rich in oil. Bolivia needs this oil, especially as an export commodity. Brazil, without oil of its own and with only inferior coal deposits, is promoting exploitation of the petroleum lands. In accordance with a 1938 treaty, it is financing the railroad project in Bolivia under the supervision of a Mixed Bolivian-Brazilian Commission.

The new line is slowly but definitely inching westward. A section of 187 miles was opened in January, 1947, marking

PHOTOS COURTESY ARGENTINE EMBASSY

SCENES IN ARGENTINA

Virtually all Argentine lines have been taken over by the government, which launched a 5-year plan of revitilization last year. It includes the purchase of locomotives and cars from the United States. The railroad system suffered during the war, when traffic was heavy and replacement of equipment was wellnigh impossible. The restriction on importation of coal resulted in a fuel shortage, and large quantities of wood, oil-bearing seeds, and corn were burned under locomotive boilers. Above is shown a deep cut on the route to Bolivia, with a locomotive partly visible. The station in the city of Santa Fe is pictured at the right.



COLOMBIA STRUCTURES

The chief railroad problem in Colombia is that of linking the scattered lines into a unified system. A long-range plan for this purpose was entered upon in 1945 with the hope of attaining the objective in six years. A railway bridge over the Magdalena River is shown at the left and, below, an interior view of the car shops at Cali.

DEPARTMENT OF COMMERCE PHOTOS

completion of the stretch from Corumba on the Brazilian border to El Porton, almost half the distance to Santa Cruz. This section took eight years to build and cost approximately $14,000,000. Penetration farther westward will not be a simple matter. Construction materials will have to be carried far, and the swampy terrain will make operations difficult. Nevertheless, some optimistic forecasters predict that the road will reach Santa Cruz by 1949-1950.

West of Santa Cruz, another stretch of 316 miles to Vila Vila remains to be built in order to complete the transcontinental route. Bolivia has undertaken this work, thus far without Brazilian participation. To date, the Bolivian Railroad Administration has constructed about 6 miles, including a 177-foot bridge. A Bolivian firm has finished, under contract, an additional 19-mile section exclusive of a 2559-foot tunnel, of which 755 feet still has to be driven. Beyond that, a 12-mile stretch to Mizque is being built by the Railroad Administration, but headway has been made on only 3 miles. Some work has been started east of Mizque. But as yet, none of the roadway beyond Vila Vila has tracks. Completion of the line is outlined in a 5-year plan, the success of which is contingent upon the availability of funds. The total cost from Vila Vila to Santa Cruz is estimated at $35,000,000, including $2,500,000 for rolling stock. Although Brazil is committed by treaty to help finance the project, Argentina may in the end assume that burden.

Present-day railway development in Chile has for its main objectives the completion of international lines to Argentina, the extension of branches to areas not yet served, and the improvement of various State Railway systems. Less pressing plans call for further rail electrification.

Two transandean lines have long been under construction by the Chilean Railroad Department. In the Province of Antofogasta, work is progressing on a 112-mile stretch between Augusta Victoria and Socompa, on the border of Argentina. This road, which will connect with the Argentine network, has great potentialities. It is expected to provide for the exchange of commodities vital to both nations—Chilean nitrates and minerals moving to northern Argentina, and Argentine foodstuffs, cattle, and forest products to northern Chile. It will also give Argentina access to a Pacific port through which its foreign trade may flow, aided by a comparatively short rail haul.

The second international system is the Transandine Railway in the Province of Malleco. There construction is underway between Curacautin, to which the line now extends, and Lonquimay, a distance of about 40 miles. As in the case of the northern route, it will tie in with the Argentine system and facilitate the interchange of materials between the southern sections of the two countries, which now requires a long rail or water haul. A sum of $129,000 was allocated in 1947 for the continuation of this project.

In addition to the work on these trunk lines, Chile is building branch lines or improving existing ones that will stimulate both trade and tourist travel. To further the program, the State Railways in October, 1946, obtained authorization for a $5,000,000 credit from the Export-Import Bank of Washington, the money to be spent in the United States for diesel-electric locomotives, motorcars, components for freight and passenger cars, bridge materials, rails, repair-shop machinery, and other equipment.

Uruguay's one important current undertaking is the extension toward the Brazilian border of the State Railway which runs from Florida to Blanquillo. Thirty of the 43 miles are under construction, including a bridge over the Rio Negro. Uruguayan officials believe that this road is destined to open up one of the most fertile and productive regions in the country. Cattle and sheep are abundant there, and the land produces wheat, corn, oats, linseed, potatoes, and other crops.

None of Paraguay's ten railroads have scheduled other than normal maintenance. A new line to connect with the Brazilian system extending from Santos has been discussed for several years. Some work is reported to have been done on the Brazilian side of the border, but none in Paraguay, and the future of the entire project is in doubt.

Of outstanding importance to both Peru and neighboring Bolivia is the line being built from Matarani to La Joya on the Southern Railway of Peru. Matarani is a new port completed in 1941, and is designed to replace Mollendo, about 9 miles to the north, as a place of entry for southern Peru and the Bolivian highlands. Lack of rail service has limited Matarani's usefulness, whereas Mollendo is the ocean terminal of the Southern

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TERMINAL AT CALLAO, PERU

One of Peru's leading railway projects is the development of adequate connections with Matarani, a new port completed in 1941 that is designed to replace Mollendo. The picture shows the administration office at the Callao terminal.

Railway. Need of the new link is a pressing one for land-locked Bolivia, which now depends on foreign ports that are inadequate to handle the traffic. The Matarani-La Joya line, 39 miles long and more than half finished, is being constructed by the Peruvian Government. Tracks are laid for approximately 18 miles at the La Joya end. Progress is slow, but some authorities expect completion by the end of 1948.

One other undertaking in Peru is worthy of mention: the Yauricocha extension from the Central Railway. The work is being done by the Cerro de Pasco Copper Corporation which owns copper mines at Yauricocha. The prospects are that the road, as well as an aerial tramway over the same route, will be ready for use early this year.

Indications are that Ecuador will concentrate in the immediate future on one major project—the completion of the Quito-Ibarra-San Lorenzo railroad. Its present northern terminal is Salinas, just northwest of Ibarra, and construction at different points beyond Salinas is progressing. The work was allotted about $740,000 in 1947. San Lorenzo is a deep-water harbor about 15 miles from the Pacific Ocean. Although a channel will have to be dredged through the sand shoals for sea-going vessels, authorities are of the opinion that frequent use and tidal action will keep this passage clear. The new line will give Quito a route to the ocean that will be approximately 47 miles shorter than the one to Guayaquil, and Lorenzo has the added advantage of being 500 miles closer to the Panama Canal.

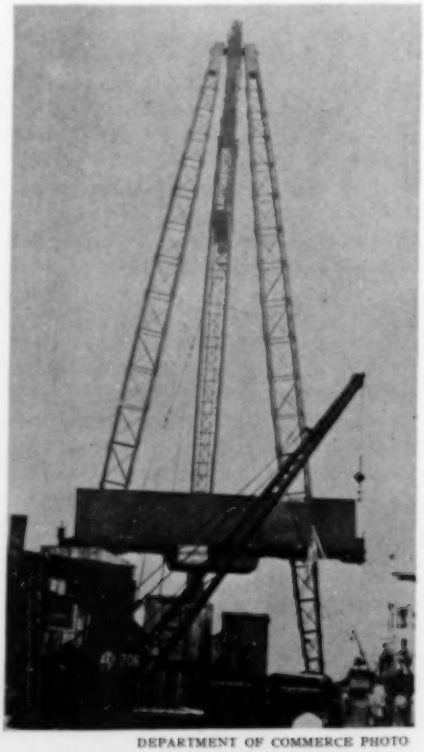
As in the case of Brazil, Colombia's primary railway problem is that of linking its scattered roads into a unified system. North-south lines are at present built around the Magdalena River, with many highways and railroads acting as feeders. Land transport on both sides of the stream consists of rail routes connected by highways supplemented by aerial cableways and primitive animal trails. To overcome the limitations of these facilities, the Colombian authorities are intent upon welding the rails into a coherent structure.

A long-range plan, embodied in a 1945 law, outlined a program and created a National Railway Fund exclusively for the construction and equipment of the Ibague-Armania, the Main Occidental, and the Main Oriental railroads. United States experts have estimated that the over-all project will require more than six years for completion. The Ibague-Armania System, which is 85 miles long, will close the only gap that now interrupts continuous rail service between Bogota and the port of Buenaventura. The Main Occidental is to extend from Cartagena on the Caribbean to Tumaco, a Pacific port in southernmost Colombia, while the Main Oriental is to be a trunk line east of the Magdalena River and will connect Bogota by rail with the Caribbean Sea.

Venezuela is the third South American republic seriously concerned with unifying its separate rail lines. On January 29, 1946, the government established a State Railways Administration to administer its four common-carrier roads and to analyze their conditions. It was also charged with the responsibility of studying methods by which to rehabilitate the lines and integrate them into a national network. In December, 1946, about $140,000 was appropriated for operating and improving the railroads and for the purchase of additional equipment.

Proceeding with its assignment, the new agency last year entered the market for rolling stock and repair parts and has been working to improve tracks, shops, stations, and other structures. It has also made efforts to expedite the movement of freight on government-owned lines. It should be pointed out, however, that railroad transportation in Venezuela has deteriorated in recent years. Highways have been gaining in importance, while railways have fallen into a serious state of disrepair. A recent study by the National Highways Commission indicates that new motor roads will be built in regions where such traffic arteries seem to be more desirable, even temporarily, than railways. Where both are deemed necessary, the latter will probably receive priority.

From the foregoing review it is clear that decades will elapse before South America will, if ever, have a railroad network comparable to that of the United States or Western Europe. It is equally clear, however, that even slight improvements in existing facilities will open up vast areas of potential wealth that are today virtually inaccessible because of a lack of modern means of transportation. Given a prolonged period of world peace, it is reasonable to expect that the railways, in conjunction with new highways and airways, will reach a point throughout the length and breadth of South America where they will bring that great continent to the high state of economic development of which it is capable.



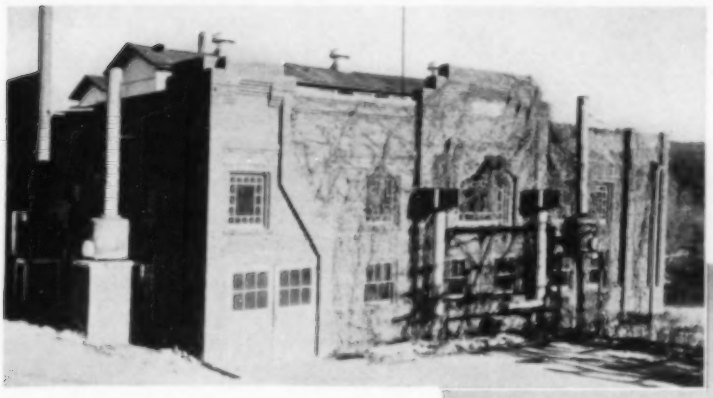
DEPARTMENT OF COMMERCE PHOTO

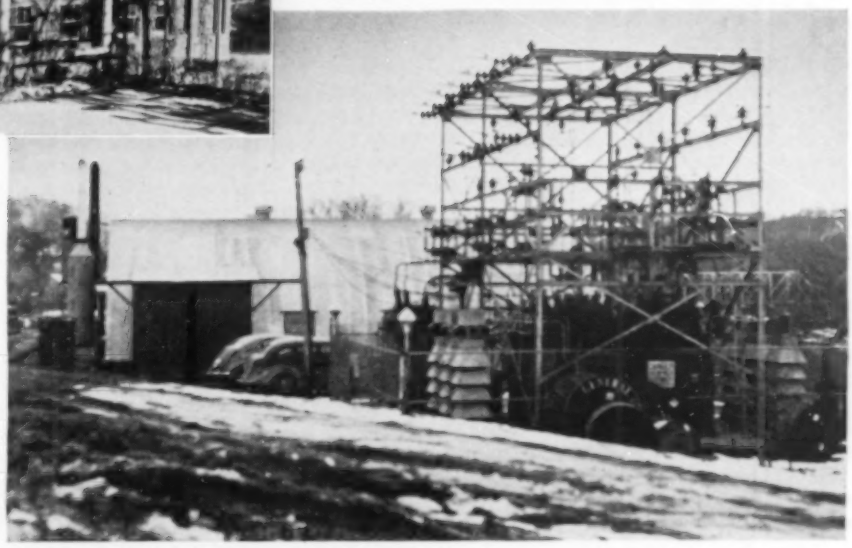
DERRICK LIFTING A CAR

A 30-ton load being shifted at a siding in Rio de Janeiro, Brazil.

Burned-Out Power Plant Speedily Restored

Spencer, Iowa, Utility Resumes Service with Three Diesel-Engine Generators 125 Days After Dis-ster





BEFORE AND AFTER

At the top is the Peterson power plant as it appeared before the fire. To get it back into service as quickly as possible, quonset-type buildings were constructed to serve until more substantial housings can be erected. The lower view shows the larger of the two provisional structures, with the substation in the foreground.

IOWANS are accustomed to warm weather in June. They even like it, because it makes the corn grow, and Iowa's economical well-being hinges largely on its corn crop. Sunday, June 22, 1947, was a typical summer day in northwestern Iowa—warm and sultry, with not much air stirring. At the close of that day, people in the town of Peterson, Clay County, and in the surrounding farming area were sitting on their porches exchanging small talk or perhaps making plans for the next day's tasks. The men were in shirtsleeves, the women in cotton dresses. It was the longest day of the year, much daylight remaining after the evening meal had been eaten and the dishes washed and put away.

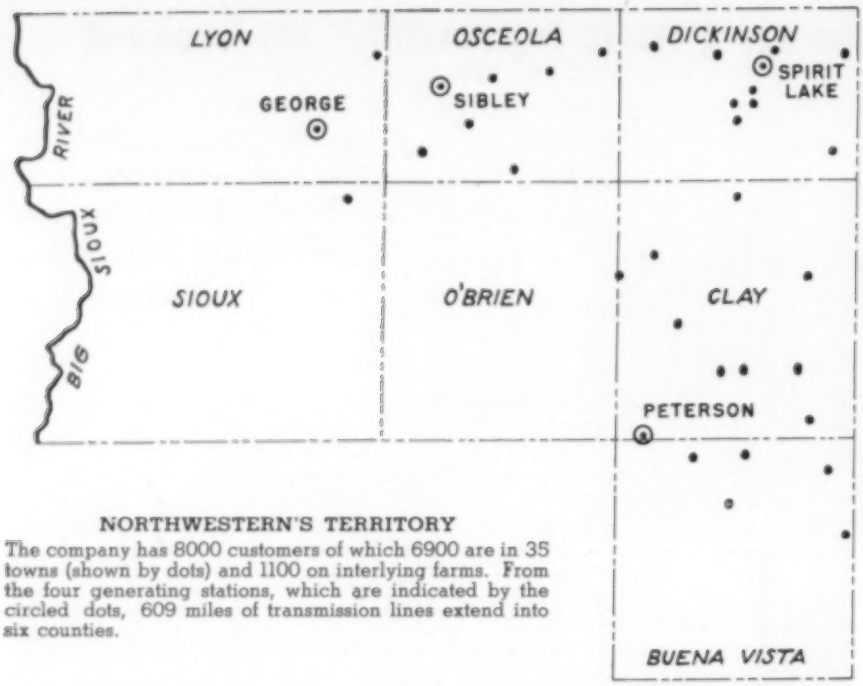
It was much like any other June Sunday; a somewhat lazy and restful day that had come as a welcome break in the weekday routine. Oldsters had indulged in the luxury of lolling in bed an extra hour or so, and they had done only such work as was necessary. Now, with night approaching, they were relaxing. Occasionally they glanced at the sky, for it was apparent that storm clouds were gathering. Rain, always welcome in farm country, was unquestionably on its way.

The storm broke around 7:30, and was accompanied by severe electrical effects. Half an hour later the Peterson generating station of the Northwestern Power & Light Company was on fire. It was assumed that a bolt of lightning was the cause, although there was no direct evidence that this was the case. At 8:23, electric clocks stopped in Peterson and in the neighboring countryside. Firemen from Peterson and nearby Sutherland fought the blaze without success because the flames had either started in or reached 1000 gallons of oil stored in the basement to fuel the diesel engines that operated the generators. Water could not be used because of the danger of electrocution, and in a few hours the building and its equipment had been destroyed, with a loss of around $450,000.

In addition to Peterson, the plant served the towns of Moneta, Linn Grove, Sioux Rapids, Marathon, Everly, and Royal, as well as the intervening farming areas. The stricken station was one of four interconnected sources of power in the Northwestern Light & Power Company's system, which supplied an L-shaped section in six counties located northeast of Sioux City. Peterson is at the south end of the territory. Other company generating plants are at Spirit Lake, Sibley, and George. Sufficient power was available from these sources partly to restore normal service in the zone affected by the fire. The current required to make up the shortage was obtained through existing tie-ins with the lines of other utilities at Albert City, Peterson, and Emmetsburg, all at the southern end of the "L." The Sibley and George stations, which normally run sixteen or seventeen hours daily, were stepped up to 24-hour operation until the Peterson plant could resume full service.

Because of these interchange agreements, which are typical of the measures regularly taken by American power companies to protect their customers, the fire occasioned no serious interruption in service All consumers in the region involved, except those in Peterson and its immediate vicinity, had current within three hours after the outage. In the case of Peterson there was a longer delay, because the automatic switching equipment was inside the building. This necessitated some rewiring outside so that switching could be done manually. The essential facilities were set up in a few hours, and service in the Peterson area was restored at 2:30 the following morning.

Coming as it did on a Sunday, the fire caused a minimum of inconvenience and discomfort to the utility's customers. Power was available as usual on Monday morning when the business, farming, and domestic activities began anew. Most electrically operated industrial equipment had been shut down over the week end, so interruption in this connection was inconsequential. In homes and on farms the break in continuity, though noticeable, was of such short duration that there was little monetary loss and no hardship. So far as the public was concerned, then, the fire had little effect, thanks to the foresight of the North-



NORTHWESTERN'S TERRITORY

The company has 8000 customers of which 6900 are in 35 towns (shown by dots) and 1100 on interlying farms. From the four generating stations, which are indicated by the circled dots, 609 miles of transmission lines extend into six counties.

western management in providing safeguards in the form of interchange agreements with concerns having interconnecting power networks.

From a company standpoint, the fire was, of course, more serious. Its customers were being taken care of, to be sure, but this imposed a burden upon other facilities that could not be carried indefinitely. It was important that the Peterson plant be rebuilt, reëquipped, and restored to service as soon as practicable. Plans were immediately put in motion to bring this about. Fortunately, diesel-engine generating units are essentially packaged machines that are assembled at the factory and shipped virtually intact, making it possible quickly to put them in place, ready to operate. True, they can't be bought off the shelf like hardware, but manufacturing schedules under our industrial system are such that relatively fast deliveries can be made in circumstances such as existed at Peterson. Actually, one new 600-hp. engine-generator set was "on the line" in 38 days, and complete equipment, consisting of three units aggregating 3240 hp., was installed and running on October 25, a trifle more than four months after the fire.

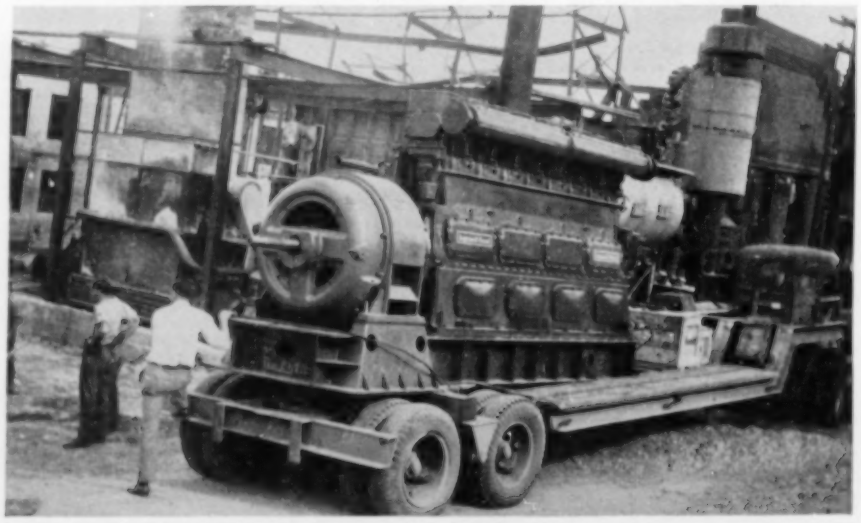
The territory in which Northwestern Light & Power Company operates is predominately rural. Agriculturally it is classified as the cash-grain area of Iowa. Unlike other sections of the state, a larger proportion of its farmland is in cultivated crops such as corn and small grains and a smaller one in pasture. Livestock, with the exception of sheep, is less numerous than in other parts of Iowa. The two largest towns of the 35 served by the Northwestern system, Sibley and Spirit Lake, have populations of 2356 and 2161, respectively, according to the 1940 census, and all but two of the others have fewer than 1000 inhabitants.

Of the company's 8000 customers, 6900 are classified as urban and 1100 as living on farms. Urban-household and retail-business consumption in this area is typical of that in most other parts of the United States. Farms use electricity for lighting and to control automatic heating and home appliances. Outside of the house, electric power operates a variety of equipment, including milking machines, chicken and pig brooders, water pumps, barn ventilating fans, hay and feed hoists, blowers and grinders, welders and farm-shop tools.

Among Northwestern's customers are twenty feed-grinding establishments and five small manufacturing concerns. The latter, listed as 150-kw. users, make a variety of products such as tank heaters, grease guns, covers for bottled gas, and die castings for lawn mowers. In addition, the company furnishes the power for the lines of the rural electrification association serving all of Lyon County and one-half of Clay and Osceola counties. The total generating capacity at all four plants is 10,860 hp.—4870 at Spirit Lake, 3240 at Peterson, 1500 at George, and 1250 at Sibley. All the units are driven by diesel engines. The company has 159 miles of transmission lines carrying current of more then 6900 volts and 450 miles for lesser voltages.

The Peterson station was constructed about 50 years ago as a steam-generating plant. When acquired by the newly organized Northwestern Company in 1925, it was powered by two steam boilers and a turbine. The steam equipment was replaced shortly thereafter by a diesel engine, and the station has been on a diesel basis ever since. Immediately before the fire it had four engine-generator sets with a total capacity of 2800 hp. Only one of these withstood the fire sufficiently to permit reconditioning, even though its generator and exciter were a total loss. The engine had been installed in the Spring of 1947.

After the fire, summer weather and intercommunity coöperation combined enabled the Peterson plant to go into



PACKAGED POWER

To help in the emergency, city officials of Spencer, Iowa, 26 miles away, permitted Northwestern to take over a 600-hp., 400-kw. generating set that had not yet been placed in service. The machine was transported by truck-trailer, as shown, and consists of an Ingersoll-Rand Type S, 8-cylinder diesel engine driving an Elliott generator. Both elements are mounted on structural-steel bases that facilitated moving them as one piece. Ruins of the burned Peterson plant are seen in the background.

partial service on July 30, just 38 days after operation stopped. Inquiries directed to several diesel-engine manufacturers revealed that an Ingersoll-Rand engine and generator had been delivered a short while before to Spencer Public Utilities, a municipally owned station at Spencer, Iowa, only 26 miles from Peterson. The unit had been ordered by Spencer Utilities as a stand-by to provide power for pumping the greatly augmented volume of water required during the Clay County Fair, which is billed as "The biggest county fair in America."

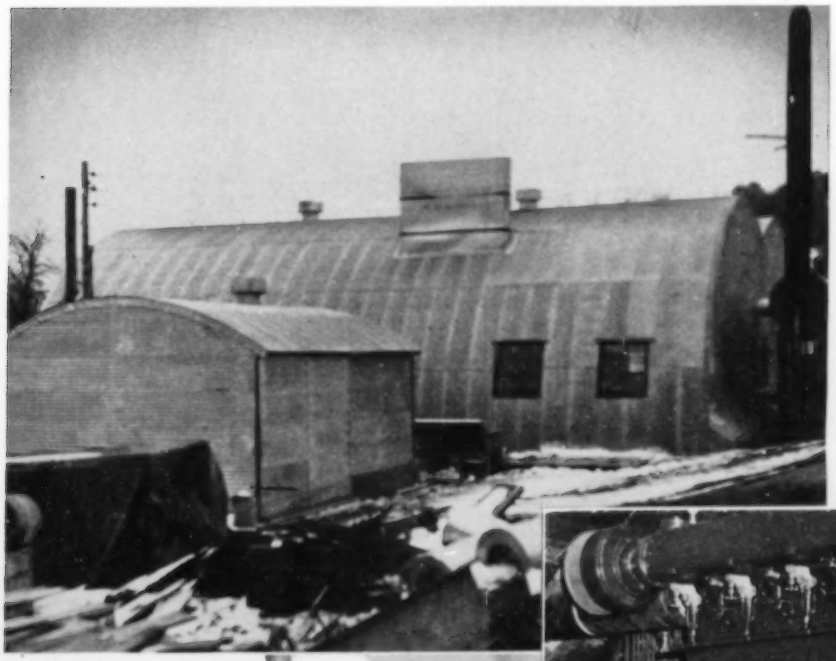
The machine had not yet been placed in service, and Spencer Utilities agreed to its diversion to Northwestern at Peterson. Need of extra power for the fair was taken care of by a 5-year interchange of power contracted in 1947 between Spencer and Northwestern. The 26-ton piece of equipment, loaded on a special heavy-duty trailer drawn by a diesel tractor, was moved from Spencer to Peterson by Marsh Brothers of Cherokee, Iowa, on July 8. The engine and generator were transported as a single unit, without the necessity of dismantling. A paved highway connects the two towns, and no difficulty was experienced during the haul, which was made in one day.

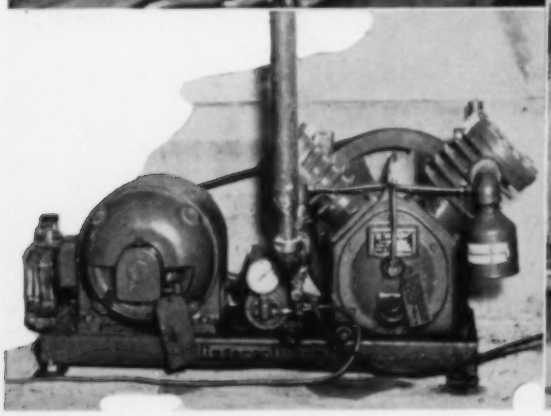
The engine is an 8-cylinder, Type S, 600-hp. unit operating at 720 rpm. and is direct connected to an Elliott 400-kw. generator. Air for starting is supplied by an Ingersoll-Rand Type 30 compressor driven by an electric motor. Installation of the machinery was begun before the structural steel-and-brick walls of the fire-gutted powerhouse had been completely dismantled. Later it was housed in a quonset-style, all-metal building 20x24 feet in size and insulated with fiber glass. After the debris had been cleared away and the engine-generators and unusable equipment had been removed, another structure of the quonset type, occupying 60x80 feet of floor space, was constructed on the site. The two buildings were erected at approximately 20 percent of the cost of conventional brick-and-steel structures of equal size.

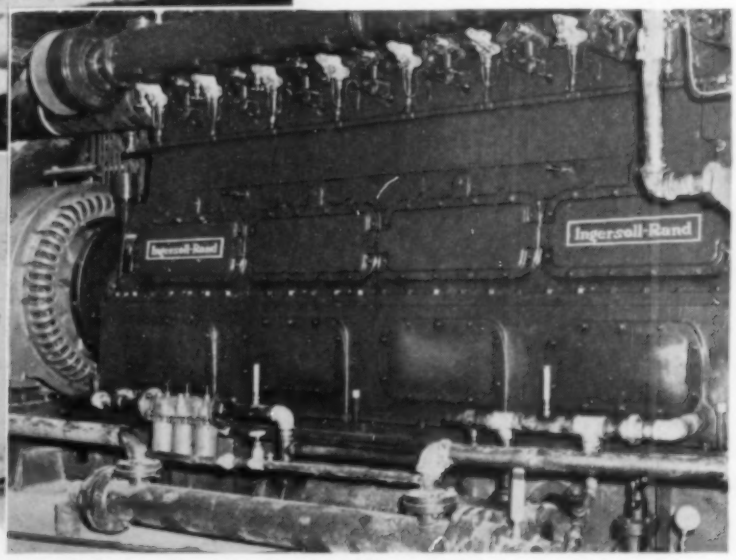
The larger building now houses a new 16-cylinder, 1440-hp. diesel engine driving a 1050-kw. generator and the 6-cylinder, 1200-hp. unit that was reconditioned following the fire and connected to a new 840-kw. generator. The first of these went into service on October 8 and the second on October 25. Thus the Peterson plant, with its capacity increased by 440 hp., was again in full operation just 125 days after the fire. The station is located on the Little Sioux River, and water for the cooling system is obtained from that source, as well as from a supplementary well. The water is clarified and softened to zero hardness.

All fuel oil for the plant is in outside storage tanks having a total capacity of 71,000 gallons. While the exact cause of the fire has not been determined, every precaution has been taken in rebuilding to prevent the ignition of inflammable materials during electrical storms. Each engine has its own underground 500-gallon fuel tank, and at no time is there more than 5 gallons inside the structures for each engine. Lubricating oil also is stored in an outside tank holding 2000 gallons, but the quantity available in the buildings is not allowed to exceed 150 gallons.

Division manager for the Northwestern Light & Power Company at Spirit Lake is L. P. LaFontaine. Louis Ammons is chief engineer at the Peterson Plant.







IN OPERATION

The first of the three diesel engine-generator units in the new plant was set up outdoors, and the small quonset-type structure in the foreground of the picture at the left was built around it. Later the larger structure was put up to house the two other units. The view below shows one side of the 600-hp. Type S diesel engine in the smaller building. At the lower left is the motor-driven, air-cooled Type 30 compressor that supplies compressed air for starting the engine.

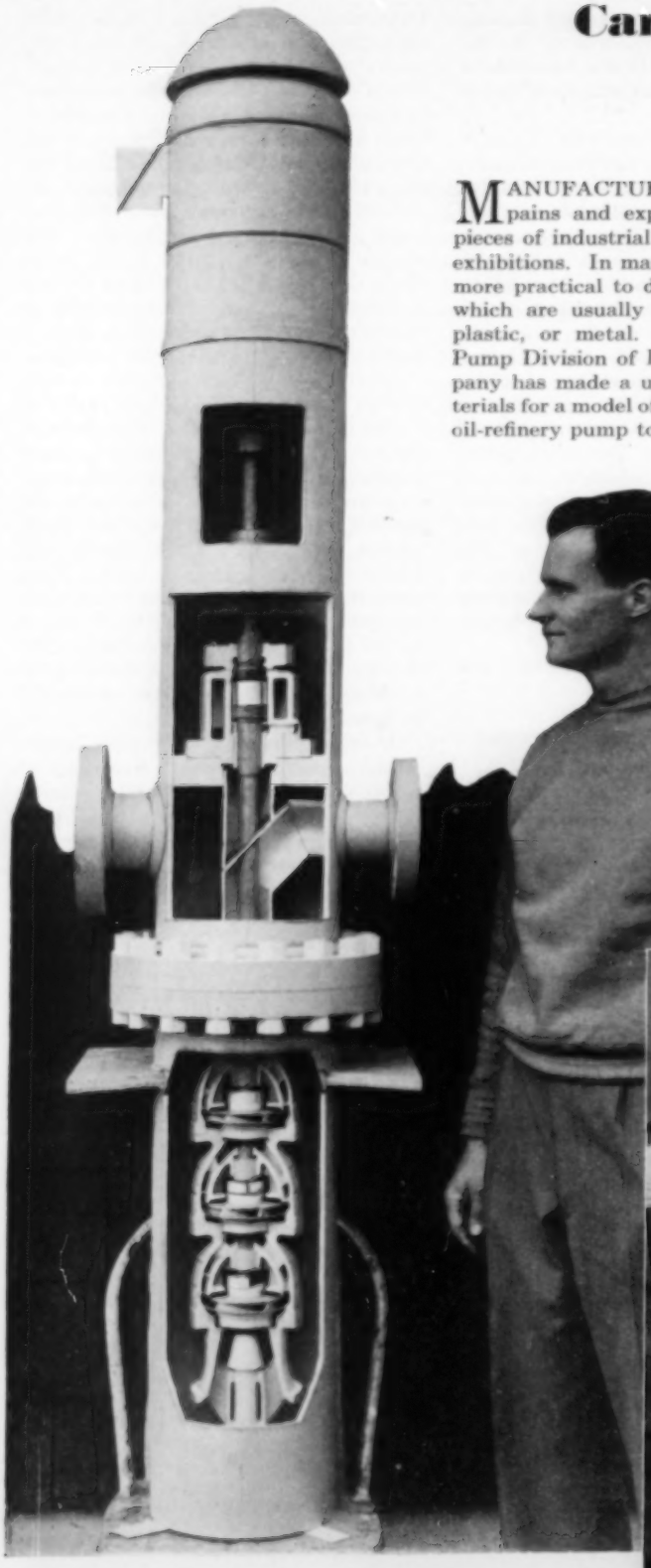
Cardboard Pump Model for Display

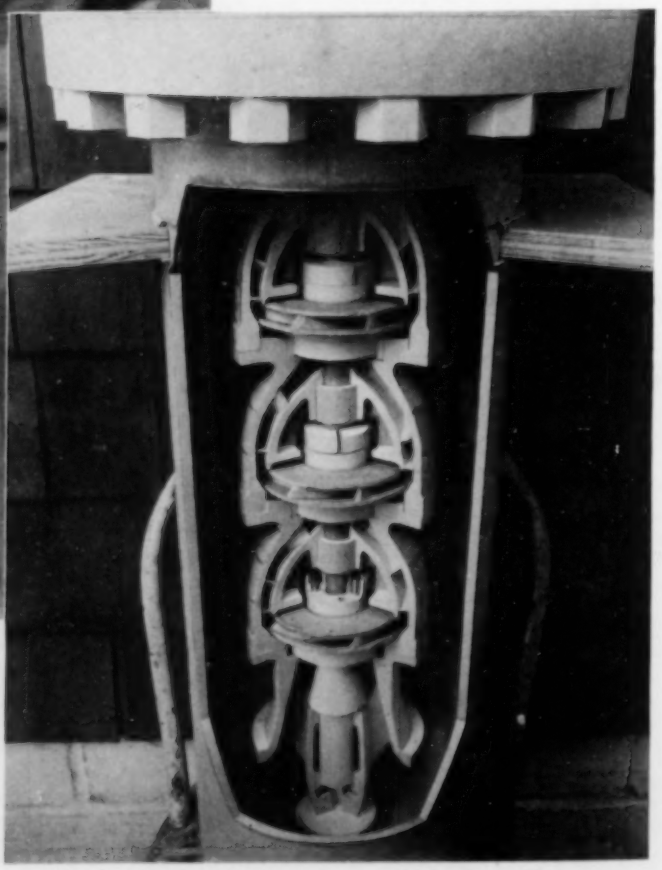
MANUFACTURERS go to great pains and expense to show large pieces of industrial equipment at trade exhibitions. In many cases it would be more practical to display scale models, which are usually fashioned of wood, plastic, or metal. But the Cameron Pump Division of Ingersoll-Rand Company has made a unique choice of materials for a model of its vertical, 3-stage, oil-refinery pump to be exhibited at the International Petroleum Exposition in Tulsa, Okla., May 15-22. Of full-scale size, 7 feet high, this model is composed almost entirely of cardboard.

There were several reasons for this choice. First, Product Models, Trenton, N. J., has proved that cardboard "mock-ups" are not only entirely feasible but also have many inherent advantages. Second, light weight is a real blessing in any industrial display. Third, the use of other materials in this model would have presented problems that were avoided by cardboard.

A model was wanted that would show all the essential details of the pump and that would look as much like the real thing as possible. Inside parts were to be exposed by appropriate cutaway sectioning; rotating parts were to be turned slowly by means of a small, hidden electric motor; and to accent the functions of the various parts they were to be given different colors.

The pump is of a vertical type with an electric driving motor at the top and three pumping stages in a casing at the bottom. It is designed for handling refinery liquids and for other applications where low submergence is required. The





MODEL AND ITS BUILDER

Morton P. Matthew standing beside the 7-foot-high, full-scale replica of an Ingersoll-Rand pump that he built almost entirely of cardboard. A graduate engineer and World War II veteran, Mr. Matthew developed what began as a hobby into a business that goes under the name of Product Models. The close view of the 3-stage pumping element at the right reveals the intricate construction and close fit of the parts. The shaft and impellers are turned slowly by a hidden motor to demonstrate how the pump operates.

entire pumping element is immersed in the fluid being pumped, and this makes it easy to obtain a positive suction head when handling products of low specific gravity. It would be difficult to accomplish this with a horizontal pump. In some cases, even the piping is placed underneath the floor line and only the motor is visible. A typical service of a unit of this type around refineries is that of pumping propane into tanks for storage under pressure.

The fluid enters through a 4-inch nozzle and fills the casing. It is pumped upward and discharges by way of a gradual bend through a 3-inch nozzle. Each pumping stage has an impeller with curved blades between converging conical surfaces. Each impeller discharges into a bowl-shaped passage with scroll-shaped diffusors that direct the flow around, upward, and back toward the center. A stuffing box, glands, mechanical seal, couplings, flanges, bearings, etc., make up the remainder of the unit.

The pump weighs 950 pounds. It would be a heavy object to ship from the factory at Phillipsburg, N. J., and back. Several men would be needed to assemble it at the exhibition, taking up both space and time, which are at a premium when preparing a display booth. Setting aside a real pump out of stock and cutting it up to show its inner workings is no small item of expense. What is more, Ingersoll-Rand wanted to show an advanced design somewhat different from any that had yet been manufactured. A model seemed to be the answer. The one made weighs only 40 pounds.

Plastic was first considered, and instead of cutaway sections the exterior was to be transparent. Such a model would have been costly, and still fairly heavy. The material also offered machining and fabricating difficulties. Wood, too, has limitations. The casings are 10¾ inches in diameter, outside, have ⅜-inch walls, and are about 3 feet long—not the easiest shape and size to turn out quickly. There is no guarantee against warping and cracking, especially in areas where walls are thin or grain direction is unfavorable. The job of whittling out 40 thin, curved, and twisted impeller blades would not tempt any woodworker.

Product Models proposed to build a pump of cardboard. In the case of this material most of the aforementioned problems do not exist, and others of a serious nature seemed unlikely. The model was ordered, and was made of cardboard with the exception of the long narrow shaft, which is of aluminum; of some thin, flat supporting plates, which are of plywood; and of a mechanical seal which is actual stock.

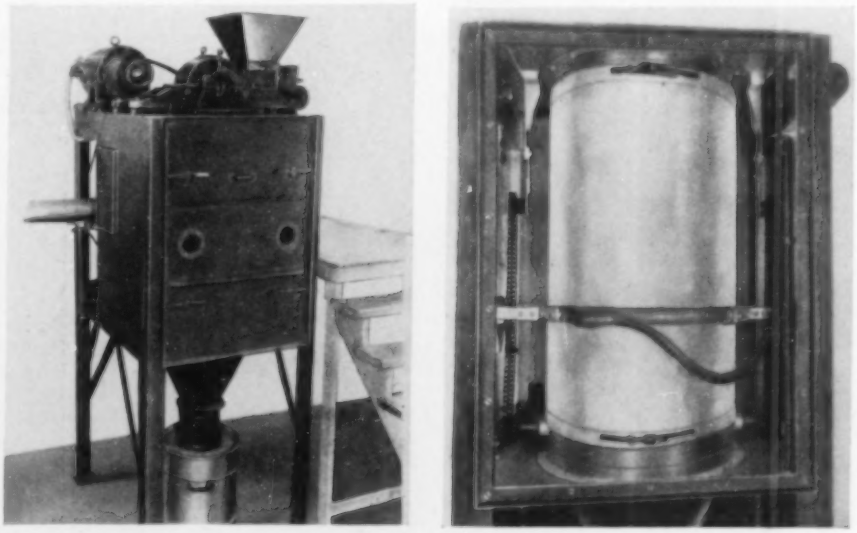
Accompanying illustrations show how successfully the idea has worked out. It is worth noting that there are four bearings in a line at the three pumping stages. The bearing housing, inner bowl, scroll blades, and outer bowl, through which each of the three upper bearings is positioned in relation to the flange mating with the succeeding stage, is an assembly of separate pieces. Even so, no special shimming or adjustment was needed to bring the bearings into alignment; the shaft fits are so close that an observer cannot readily see that there is a clearance; and the shaft turns freely in the bearings. Also of interest is the shape of the motor at the top of the mock-up. It has two surfaces with a double curvature. These were made entirely of cardboard without the aid of solid forms and in about half a day.

The technique of fabricating parts of cardboard has resulted in satisfactory working models of spur, bevel, helical, and worm gears in simple and in planetary reduction, of screw threads, splines, roller bearings, and turbine blades. Even a complete gas turbine has been reproduced. Sometimes the most unusual is the most practical, and the cardboard pump mock-up is a case in point. After the exhibition closes, the model is to be set up in the Cameron engineering offices at Phillipsburg.

Dust Collector with Pneumatic Cleaner for Filter Bag

WITH the introduction of its Mikro-Collector, the Pulverizing Machinery Company has entered the dust-collecting field. The unit is said to be a departure in several respects from conventional equipment of this kind and is suitable for filtering room air or for use as an auxiliary to pulverizing, processing, or materials-handling machinery. The filtering medium is in the form of a cylindrical bag of hard-pressed wool felt which, despite its thickness and the fineness of its pores, is prevented from clogging by a hollow, annular blow ring that is moved up and down by chain and sprocket drive. This ring hugs the bag and flexes it by a countercurrent of air delivered through a hose connection and escaping from a narrow slit on the inner periphery of the ring. It is claimed that cleaning by this method is so thorough that the filter is always available for service without loss in efficiency.

Either positive or negative pressure may be used to induce the air flow through the bag. In the case of the former, the dust is blown directly into the filter by means of a fan; by the more frequently employed negative pressure, the fan draws the air from the clean-air chamber between the bag and the air-tight cabinet in which it is centered. The dust-laden air is admitted through an opening in the roof of the housing, is caught in the radially directed air stream, and is swept against the inner surface of the bag. Some of the particles cling to the fabric, forming a layer of dust that is dislodged by flexing the felt, as described. The solids fall into a conical discharge hopper and the clean air can generally be recirculated. About 35 standardized single-bag units are in service, and operating records indicate filtering rates ranging from a minimum of 8 cfm. per square foot of filter surface to 30 cfm. and more. The average is 20 cfm. per square foot.



COMBINATION UNIT

At the left is a direct-discharge dust collector with a pulverizer mounted on top of it. The cabinet, made of steel or aluminum, houses the cylindrical filter and, beneath it, the positive-pressure blower that provides the air for flexing the felt bag, the exhaust fan, the driving motors for these units, and the conical discharge hopper. The other picture shows the filter with its encircling blow ring and flexible hose connection. Small and large single- and multiple-bag units are being manufactured.

Copra Gives Us Essential Oil

J. Walter Frates

AMONG the shortages created by World War II in the Western Hemisphere is edible oil derived largely from copra imported from the Philippines, Guam, and other South Pacific islands. Lack of ships cut off that source of supply and led to the building up of large stock piles of the material especially in the Philippines.

Today, to meet the great demand for edible oil, more than 45,000 tons of copra is entering the United States each month. Of this quantity, some 25,000 tons is passing through the San Francisco Bay area of California alone, and because of this fact the authorities of the Port of Oakland, which is situated on the mainland side of the bay, have taken steps to insure the rapid transfer of the material from freighter to waiting truck or railroad car. A battery of three blowers has been installed there and provides what is reported to be among the fastest and most efficient equipment of its kind on the West Coast for the unloading of bulk copra.

Copra is obtained from the fruit of the coconut palm, and palm oil and other products derived from it have been used since the days of Cleopatra for religious, civil, and personal purposes. Coconuts, when fully ripe, contain only a small quantity of milk, most of it having coagulated to form the thick, fleshy "meat" that is approximately 30 to 40 percent oil and 50 percent water. The nuts are collected, split into pieces, and dried, the meat shrinking away from the shell in the process.

The yield from 1000 nuts is 440 to 550 pounds of copra containing about 10 percent of water and 63 to 65 percent of oil when kiln dried and as much as 74 percent when dried by hot air. The material is crushed and then heated to rupture the cell walls before it is put into hydraulic presses. Two pressings are usually required to extract all the oil from a batch of copra. The crude oil is sold to refineries or to other industrial plants, while the meal that remains, either in concentrated form or mixed with other feed, is fed to dairy cattle.

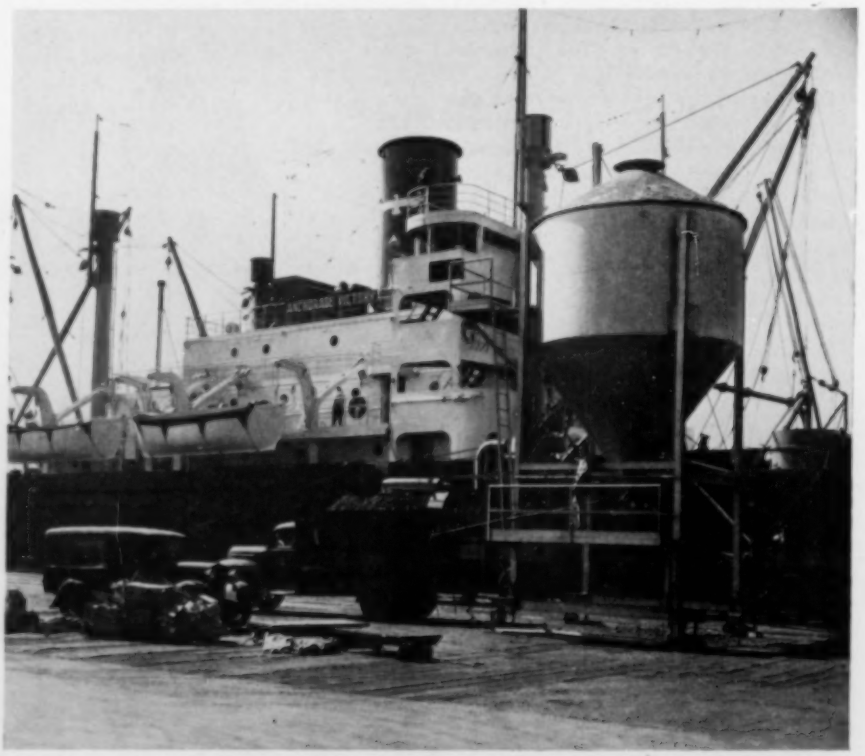
Copra enters mainly into the manufacture of margarine, mayonnaise, soap, plastics, nylon, paints, and special oils. It has but one competitor in the vegetable-oil field, and that is the babassu nut which grows wild in Brazilian jungles on a tree resembling the coconut palm. The kernel yields nearly 67 percent of oil, which is used in Brazil as a substitute for olive oil and butterfat. Because the babassu will burn when ignited with a match, it is called the Brazilian "candlenut."

Before the war began copra was unloaded in the San Francisco Bay area with the aid of blowers provided by the California Stevedoring Company, which had contracted to handle the cargo. At the end of the conflict, however, the Oakland Board of Port Commissioners decided to install equipment of its own and purchased three modern blowers for the Seventh Street Unit of the Outer Harbor Terminals. Mounted separately on movable platforms and powered by diesel engines, they are the only self-contained units on the Oakland side of the bay that are capable of serving any one of the port's terminals.

When in operation, a blower is generally stationed on the wharf next to the ship to be unloaded. A long, flexible pipe is run from the unit up over the side of the vessel and down into the hold, where men with shovels feed a steady stream of copra to the open end of the tube through which it is carried by suction to a cyclone chamber. From there it is blown through similar piping into waiting box cars, into a hopper used for loading trucks, or into a shed to await shipment. To facilitate the storage of bulk copra, the shed is provided with portable plank barricades 8 feet high. These can be shifted about readily to form bins holding quantities ranging from a few tons to a thousand and more.

Although the blowers have a rated capacity of 30 tons an hour each, the actual tonnage moved depends upon a number of factors—chiefly upon the speed with which the men in the holds feed the loose material to the suction pipes. The best performance record to date was made on November 19, 1947, when two units discharged 290 tons of copra from the *Trein Maersk* at the rate of 58 tons per hour for five hours.

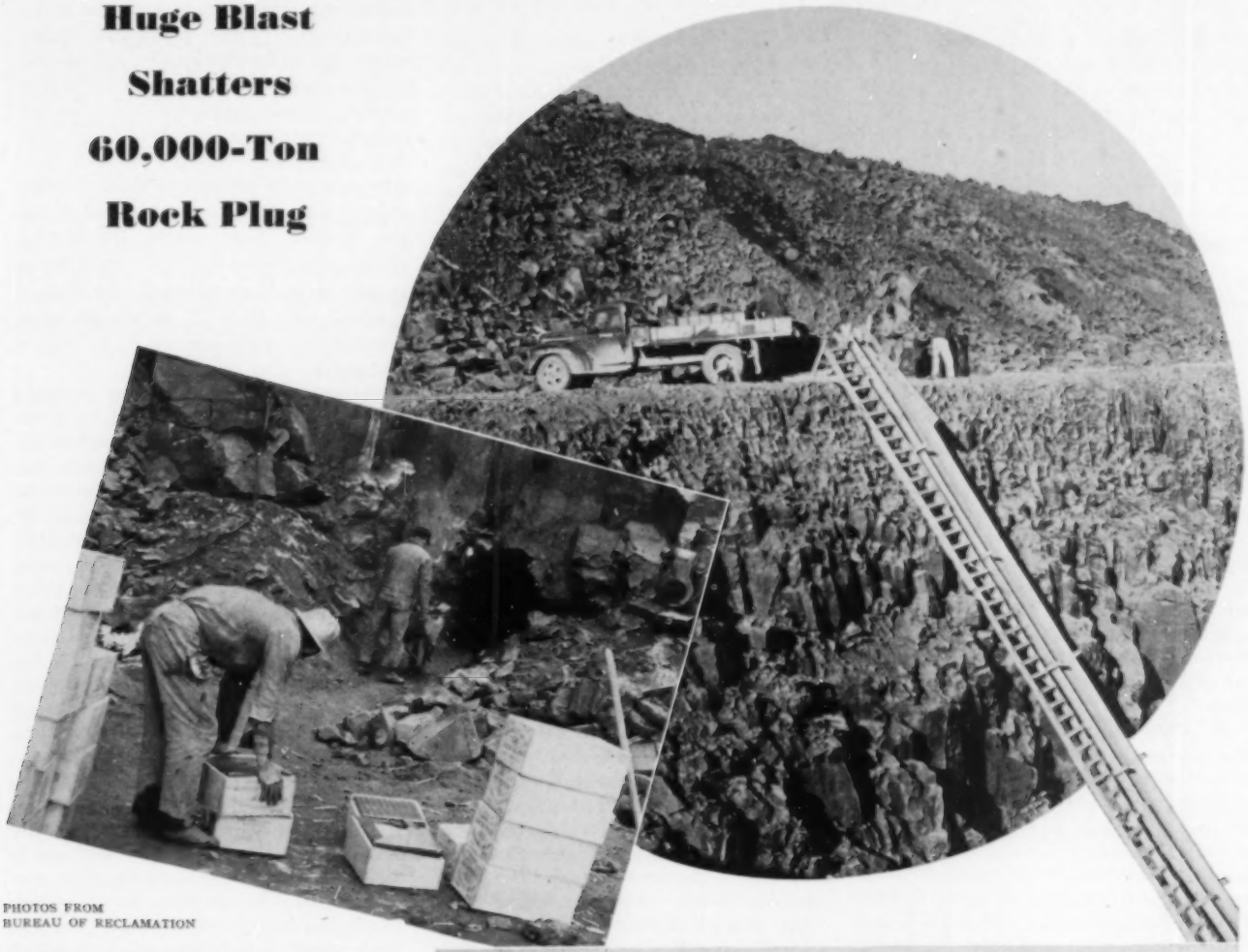
It has been suggested that the blowers be used to unload bulk sand as well as granular products that are to be processed, in which case shattering of the grain is of no consequence. But sand, others point out, is not suitable because of its abrasive character, for even copra, though an oily and waxy substance, has caused elbows in the flexible pipe and curved sections of the blower inlets to wear out through friction. Officials of the Port of Oakland, however, are not concerned about this discussion because the demand for vegetable oil is so great that it is unlikely that the equipment will handle anything but copra for some time to come.



UNLOADING COPRA IN OAKLAND

The bulk material is conveyed from the ship's hold to the hopper on the pier by means of a pneumatic-tube system. It is then loaded into trucks, one of which is seen pulling away. One of the two blowers that serve the tube is visible just above and back of the truck. Blower units and hopper are wheel-mounted so they can be moved about readily.

Huge Blast Shatters 60,000-Ton Rock Plug

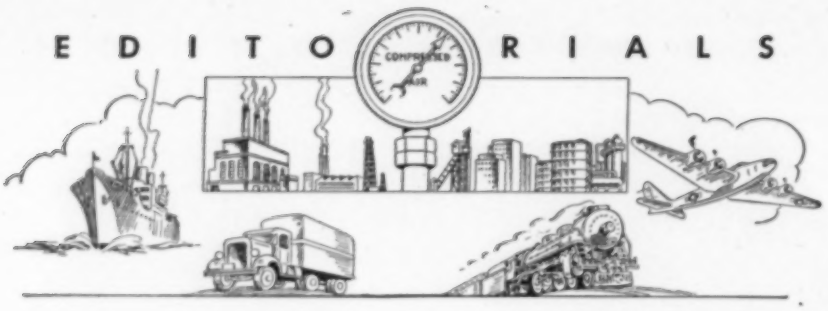


PHOTOS FROM
BUREAU OF RECLAMATION

IN EXCAVATING a section of the Main Canal of the Columbia Basin Project near Coulee City, Wash., for the U. S. Bureau of Reclamation, the contractor, J. A. Terteling & Sons, left the material in place at one point to serve as a crossover for equipment. After all but this part of the work had been completed, the "bridge" was removed. It consisted entirely of rock, weighing an estimated 60,000 tons and rising to a height of 90 feet from the bed of the channel, which is 50 feet wide at the bottom and 144 feet at the top.

The plug was blasted with 17,000 pounds of dynamite, of which 15,000 pounds was war-surplus material. A coyote hole was driven 100 feet into the base of the barrier, with four laterals branching from it and terminating in small rooms. The explosive was distributed among these openings and detonated.

Pictures show phases of the work and the result. At the top are boxes of dynamite being unloaded from a truck prior to being lowered down a chute to the canal bottom. The powder was then placed in bags and transported into the coyote hole in wheelbarrows (center). The lower view shows the blast, which broke the material much as had been expected.



HELPING UNCLE SAM

TWO proposals aimed at giving Uncle Sam something in return for his assistance to overseas nations under the European Recovery Plan seem to possess merit. One of these, put forward by W. L. Batt, industrialist and wartime government official, suggests that each of the recipient countries reimburse us with raw materials urgently needed for our national emergency stockpiles. The second recommendation is that they send us a ton of essential scrap metal for every ton of supplies and equipment we ship to them.

Mr. Batt points out that in the event of a war in the near future we would be at a "desperate disadvantage" because of shortages of such strategic materials as tin, manganese, and bauxite, the last of which is the ore from which aluminum is produced. Among the sixteen coöperating European nations and their colonies all these substances and others are found in abundance. Here, on the other hand, we have been stripped of them to the point of scarcity through the abnormal demands of two wars, together with our heavy domestic consumption and some wastefulness during the past century and a half.

The proposition regarding scrap is backed by the National Founders' Association and is being vigorously voiced to members of Congress, with the hope that some such arrangement will be embodied in the Marshall Plan. Insufficiency of scrap in the United States is obliging foundries and steel mills to use disproportionate quantities of virgin metal, with a consequent drain on irreplaceable natural resources. It is estimated that from five to ten million tons of scrap lie idle in western Germany alone.

Meanwhile, the Steel, Foundry & Scrap Industries' Committee for Expediting Iron & Steel Scrap is endeavoring to get action on a bill introduced in the United States Senate which provides for the return to industrial channels of the maximum possible tonnages of ferrous scrap and other ferrous materials that are known to be in the possession of U. S. Government agencies in substantial amounts at home and abroad. It is the committee's contention that "without a scrap program there will be continued steel shortages in the domestic economy . . . and no European recovery, which depends in the final analysis upon the availability of steel." The bill was introduced by Sen. Edward Martin of Pennsylvania and later referred to the Banking and Currency Committee of the Senate. More recently, a companion bill was introduced in the House of Representatives by Rep. James T. Patterson of Connecticut.

It was proved during World War II that the side possessing the greatest store of such resources as oil, iron, aluminum, copper, and other strategic materials eventually is the victor in an international armed conflict. Some exponents of a strong America suggested at the end of hostilities that we bring back from the fighting areas all available supplies of scrap and other essential resources and thus create huge stockpiles as insurance against future national emergencies. They argued that if these were maintained, no nation or group of nations would be likely to break the peace with us.

The latest proposals do not go that far, but carrying them out would do much to popularize the European Recovery Plan in this country. It would be comforting to know that Uncle Sam also was participating in the benefits the plan is to bestow.

●

AN AGE OF GIANTS

IN WESTERN AFRICA and some other places, open-pit mining is still carried on largely with the power of human muscles. An endless chain of natives, with each human link carrying a basket, moves on tortuous trails up from the pit and down again. The gait isn't fast, but the chain seldom stops. Each burden bearer is paid a living wage and is apparently happy. Now and then engineers with an eye to efficiency seek to replace this primitive method of transportation with modern machinery. On several occasions loading equipment and trucks have been put to work. Each time this happens the white man learns a lesson.

The natives aren't geared to running machinery, and Europeans have to be brought in. They command higher wages, don't like the climate, and usually leave as soon as their contract period expires. Some money is saved on the actual operations involved, but the natives who are displaced are still there and have to be fed and clothed. Sooner or later the machines are disposed of and the human chain starts functioning again. The lesson the white man learns is that in such an economy the human machine will, all in all, do the job more satisfactorily than one run by an engine and gears.

Things are different in the complex civilization we have built up on these shores. Ours is truly a world of machines. Men are necessary to operate them, but an increasing percentage of our technical brain power is being directed towards designing and building mechanical contrivances. As machines become completely automatic and foolproof, fewer people are required to watch over them. We are approaching the day when more persons will be engaged in planning and constructing machinery than in running it. There are good reasons for this, of course. With rising costs of labor and materials, mechanization offers an opportunity to do things faster and thus cut expenses.

This trend towards mechanization has taken a new twist in recent years, especially in the field of excavation. The current demand is not alone for more machines but also for bigger ones. The new heavy-duty rock drilling machine which was announced in our March issue serves to direct attention to this movement. It puts in large-diameter blast holes and was born of necessity created by the continually mounting cost of handling a unit volume of material. Public agencies charged with the responsibility of providing highways, airports, and numerous other works without unduly increasing the tax burden are beset with perplexing problems. So, too, are private producers of stone, iron ore, and other materials that are quarried or mined by the open-pit method. Contractors, likewise, have felt the pinch of keeping bids low enough to get business and still make a profit.

With each turn of the climbing cost spiral greater pressure has been put on machinery manufacturers to develop equipment that will help to offset the added burden. So far they have met the challenge remarkably well, but there is, inevitably, a limit to what they can accomplish. In underground mining there are space restrictions that control the size of machines. The same applies to some degree in factories. Out of doors, on the other hand, the sky is the limit. Consequently, this is an age of giant mechanical devices. If the trend continues, the feats of legendary Paul Bunyan may be surpassed.

Gauge Blocks Checked for Accuracy by Means of Air

BY A METHOD developed by The Sheffield Corporation, the length of precision gauge blocks is being checked accurately, it is claimed, without the usual danger of distortion or minute wear. There is no gauge-point contact—the only pressure exerted on the work is that of a stream of air flowing against the upper and lower surfaces. The comparator used consists of a gauging unit and of a Precisionaire—a base recording instrument having a freely moving float—with amplifications up to 40,000 to 1. Each minor graduation of the scale represents one millionth of an inch.

The gauging unit has one air jet in its diagonally serrated anvil and another in the gauging head mounted on a vertically adjustable bracket. Both jets are supplied with air from a hose connected to the Precisionaire. The gauge blocks are checked against a master calibrated set of blocks that are used in setting up the comparator and in obtaining a zero reading. The block to be checked is placed on the anvil and between the two jets. Any change of the float from zero indicates a deviation from the master, and the amount is read directly from the Precisionaire scale. If the deviation is within the allowable observation error limits set by the U. S. Bureau of Standards, the block meets all requirements.

Sheffield uses the method to check its own gauge sets, as well as those of other manufacturers. For comparison of other external dimensions of either flat or plane-surface parts of a less critical nature, the gauging unit may be used with Precisionaires of lower amplification.

COMPARATOR IN USE

The Precisionaire (left) and the gauging unit with which it is connected by a flexible hose that supplies low-pressure air to the anvil and to the column-mounted head between which the block to be checked is placed. With this set-up, Sheffield keeps the many gauge sets in continuous use throughout its plant up to standard. Each is checked three times against a zero reading, and any deviation from that reading is registered by a float moving freely in the indicating tube of the Precisionaire.

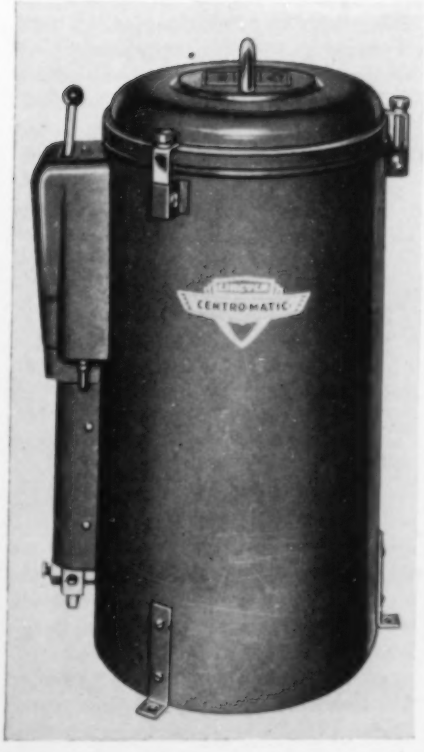
Metallizing Gun Uses Less Air

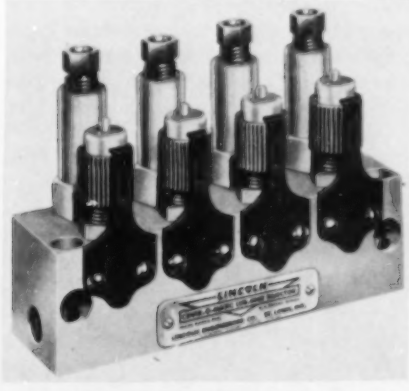
METALLIZING, a process whereby molten metal is sprayed onto surfaces by means of compressed air, is used in many industries for building up the wearing surfaces of shafts, bores, spindles and other pieces of machinery. Metal such as babbitt, bronze, carbon steel, stainless steels, or zinc is fed in wire form into a gun, melted in an oxyacetylene flame, and is then atomized and blown from the nozzle. For plants that do no need a large installation, the Metallizing Engineering Company, Inc., has added a light-duty outfit—the Type L—to its line.

According to the manufacturer, metallizing guns generally require between 25 and 30 cubic feet of air per minute in order to function efficiently. Some of this air serves to operate the turbine which feeds the wire into the flame; the remainder is used to vaporize the molten metal. It is claimed that the Type L, because of changes in turbine and nozzle design, operates on 10 cfm. and at the same time lowers the consumption of oxygen and acetylene.

A supply of 30 cubic feet of air per minute calls for a compressor driven by a motor of approximately 7 ½hp., while a 3-hp. compressor would suffice to furnish the air for the Type L gun, thus effecting a considerable reduction in equipment cost. The new gun weighs 4 pounds and 2 ounces, has a turbine control that needs but one adjustment for the entire range of metallizing wires, and requires no change for machine mounting.

Automatic Mass Lubricating System





INJECTORS AND PUMP

Above is a set of four injectors which may be replaced or removed for cleaning without disturbing the base block and supply line. This assembly is 4½ inches long, 1⅜ inches wide, and 2⅞ inches high. Each injector serves one bearing. The lubricant pump (left) has an over-all height of 24½ inches. The pumping mechanism is beneath the container, which has a capacity of 60 pounds and is provided with a follower plate to facilitate priming lubricants that have a tendency to channel. Controls are mounted on the side of the housing for ease of filling.

FOR the mass lubrication of machinery, especially where mounting space is limited, Lincoln Engineering Company is offering a centralized system that dispenses either oil or grease in measured quantities. It consists essentially of a new type of injector, designated as the SL-3, and of an automatic pump powered by an air motor. The injector is of steel construction to withstand high pressure and has but two moving parts—valve stem and piston. These operate in packings of Linpak, which is a grease-and oil-resistant material that compensates for normal wear. Individual units, or groups of two, three, or four are available and are secured to base blocks drilled for either vertical or horizontal mounting. Each injector serves one bearing, to which it is connected by tubing. A single line from the pump serves the system, and the lubricant enters and leaves the injectors under line pressure. Each can be set by a knurled knob to deliver the required amount to the bearing, and a spring clip-lock prevents any change in setting through machine vibration or other cause. Maximum injector output per cycle is 0.004 ounce.

Industrial Notes

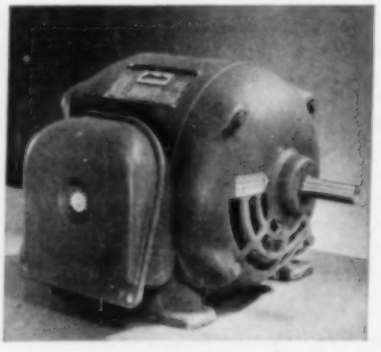
An adjustable-stroke piston is the feature of a pneumatic cylinder recently announced by Anker-Holth Manufacturing Company. In addition to the regular piston, it has a stop piston at one end by which the stroke of the piston rod can be lengthened or shortened within its limits. This is done by turning a

hand wheel that engages a threaded, hollow shaft which extends through the cylinder head to the stop piston. At the adjusting end, air is admitted to the cylinder through the hollow shaft by a flexible hose to permit movement of the shaft. The other air port is in the cover at the piston-rod end. The stop piston is provided with packing to prevent air leakage. It is claimed that the new cylinder may be used to advantage in place of several of the set-stroke type where applications require the same pressure but strokes of varying length. The device has been given the name of Airgrip and is available in bores ranging from 3 to 10 inches and with a maximum stroke of 24 inches. The model shown has a 4½-inch bore and is built for foot mounting.

According to reports received in London over the Moscow radio, Soviet scientists have succeeded, after years of research, in converting quicksands into solid foundations for buildings and in preventing its formation under existing structures. This is done by introducing two solutions under pressure. The first is water glass, which displaces the water in the sand and envelops the myriad grains. The second is calcium chloride. This reacts with the water glass, forming a compound that turns the quicksand within ten days into a compact mass that can hardly be distinguised from natural sandstone.

Fuse-ite is the trade name of a new plastic belting that originated in Switzerland and is now being distributed throughout the United States and Canada by Jules Borel & Company. It is designed for delicate work calling for light power loads and is being used extensively in the manufacture of watches. To form an endless belt, ends are brought in contact with a heated blade (300°F.) and then held together, any surface irregularities at the joint being removed by a knife or grinding wheel. The tensile strength of the connection is said to be the same as that of the belting. Other claims made for Fuse-ite are that it does not require the application of special preparations to insure smooth power transmission and that it is resistant to temperature extremes and to the deteriorating action of lubricants as well as acids up to 20 percent in strength. Flat, round, and V-belting from 0.039 to 0.59 inch in diameter is available.

Westinghouse Electric Corporation has added to its Life-Line motors a single-phase, capacitor-start, induction-run squirrel-cage motor in ratings of ¾ to 7½ hp. Of all-steel construction, the Type CAP has self-sealed, prelubricated ball bearings that will serve for five years or longer before necessitating repacking. Air openings in the lower half of the end brackets give full protection against dripping liquids. The motor is available for 25-, 50-, or 60-cycle, 110- or 220-volt



operation in a speed range of 970-3450 rpm. It is suitable for single-phase application such as driving garage compressors, pumps, and machine tools, and for refrigerating and air-conditioning units.

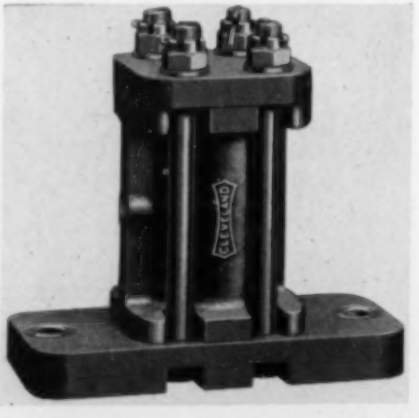
Levalarm is the name of a new device designed by The Reliance Gauge Column Company to set off warning signals when liquid levels in small boilers or tanks of various kinds reach predetermined high or low levels. Bells, sirens, or lights function when an electric switch is operated through the medium of a permanent magnet controlled by the rise and fall of a monel float. The switch is dust-, vapor-, and explosionproof and can be wired for a normally open or normally closed circuit. The control is suitable for use with pressures up to 250 psi.

For service where severe corrosion and high-temperature conditions are encountered, Titeflex, Inc., is making its flexible metallic tubing from monel metal and for operation in four temperature ranges. It is resistant to the action of mineral and organic acids, alkalies, and salts and can be used in both high- and low-pressure steam lines. It is available in same sizes and with same type fittings as standard brass Titeflex tubing.

For sealing shrinkage cracks between glass blocks, now a common building material, the American Fluresit Company has produced a compound that is said to insure a tight bond that expands and contracts with the glass and mortar. The sealant can be applied with a calking gun or, after thinning, with a brush, and forms a rubbery waterproof seal. It comes in white and colors.

Looking back on winter with its overabundance of snow and ice, it may be a comfort to the motorist to know that he can, in future, sand his path as he moves along. At least Jack Deagan, who devised the system to make his daily commuting safer, claims that it prevents skidding. The sand is carried in a tank in the trunk compartment and is piped just ahead of the rear wheels when the driver pushes a release. The container is provided with an agitator to loosen sand that may clog the outlet pipes.

Bulk materials such as sand, cement, lime, coal, ore, grain, etc., have a tendency to arch over in bins, hoppers, chutes, etc., or to plug them up, and to keep the stuff feeding freely it has to be jarred loose. One way of doing this is by the use of vibrators which have been especially designed for the purpose and do their work without damage to walls and equipment. The Cleveland Vibrator Company has recently announced improvements in its vertical Type F pneumatic unit. Its moving parts have been chromium plated and its base has been redesigned to insure intimate contact with the surface to which it is attached.



Blows are directed at right angles to the mounting, and the number of vibrations transmitted through the piston varies from 750 to 1525 per minute, depending upon the length of the stroke. There are five sizes ranging in over-all height from 7⅜ to 12 inches and using from 9 to 90

cfm. of air at 75 pounds line pressure. A horizontal Type T also is available, and both units, in addition to the application described, have numerous uses in foundries and are suitable for vibrating finished parts and mechanisms undergoing fatigue testing.

Though designed primarily for push-button control of small pneumatic presses and similar machines, Hannifin's new electric 4-way valve is said to serve equally well with the aid of limit switches and mechanical stops as an automatic control for any air-operated unit. It is

described as a packless, reciprocating, disk valve that is pilot operated and solenoid controlled. There are two types: In one, arranged for double-solenoid operation by two push buttons or limit switches, valve position is determined by energizing the proper solenoid. The other is designed for power offset operation and uses a single push button or limit switch, the valve returning to its initial position when the solenoid is de-energized. Manufacturer claims 180 and more operating cycles per minute for each type using any air pressure within the range of 25-150 psi. There are three models tapped for different inlet-cylinder and exhaust-pipe connections. Standard types are built for 115-volt, 50-60 cycle circuit.

By means of an electronic comparator announced by General Electric Company, the work of separating metallic parts that look alike but differ in composition or treatment is said to take relatively little time. The indicating instrument is mounted in a steel cabinet to which is connected an external test coil in which is placed a reference specimen for a lot of parts to be checked. After adjustments have been made to determine initial balance, and tolerances have been established, parts are inserted in coil one at a time. Coils range in diameter from ½ inch to 3 inches and leads are of sufficient length so work can

I'M YOUR MAN

IF YOU WANT GREATER ECONOMY IN *YOUR* PIPING SYSTEM!...

LOOK AT the two-bolt simplicity of my Victaulic Couplings. They greatly speed up the assembly, repair, or salvage of *any* piping system.

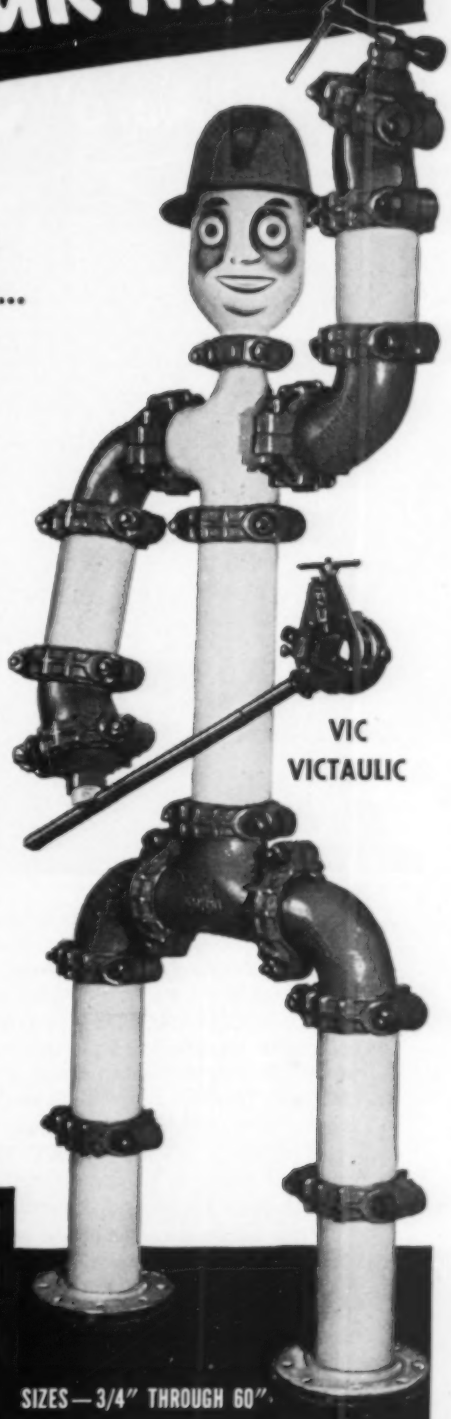
AND LOOK AT the wide, smooth sweeps of my Victaulic *Full-Flow* Elbows, Tees, and other Fittings. They reduce frictional losses . . . increase your pipeline output *at lower pumping costs.*

YOU SEE in my left hand a T-wrench . . . the *only tool* you need to button up a Victaulic system.

NOW LOOK AT the "Vic-Groover" in my right hand. It's a *new* tool that automatically grooves pipe ends exactly right . . . with twice the speed and half the effort of ordinary pipe threaders.

MISTER, if you want a pipe line that's *flexible* . . . has a union at every joint . . . can't blow off or pull out under pressure, vibration or sag . . . saves you money at every step —I'M YOUR MAN!

Write today for Victaulic Catalog and Engineering Manual No. 44 . . . and for *new* "VIC-GROOVER" Catalog No. VC-47.



SELF-ALIGNING PIPE COUPLINGS

VICTAULIC

EFFICIENT FULL-FLOW FITTINGS SIZES—3/4" THROUGH 60".

VICTAULIC COMPANY OF AMERICA

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

Victaulic, Inc., 727 W. 7th St., Los Angeles 14, Calif.

Victaulic Company of Canada, Ltd., 200 Bay St., Toronto 1

For export outside U. S. and Canada: PIPECO Couplings and Fittings: Pipe Couplings, Inc., 30 Rockefeller Plaza, New York 20, N. Y.

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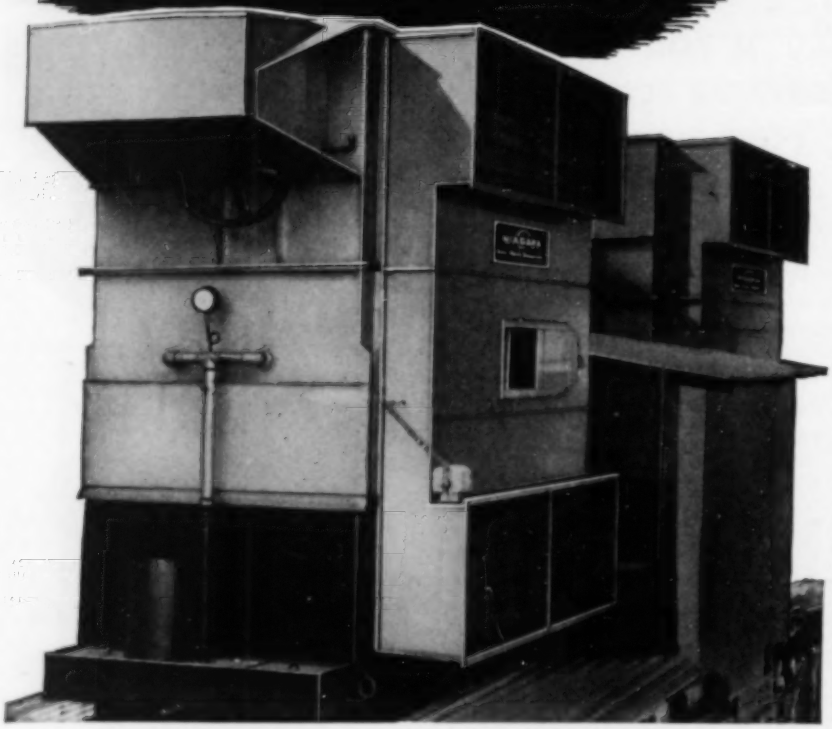
Improve Physical Properties with NIAGARA "Aero" Cooling



● Better control of quenching temperatures improves the heat-treating process, gives better physical properties to steel, increases production with fewer rejections.

That is the experience with the use of NIAGARA AERO HEAT EXCHANGERS, providing faster and more accurate cooling to specified temperatures for quench baths, either oil or water. Production is increased; unit costs are lowered. Commercial heat treaters have increased profits; heat treating departments have contributed savings.

NIAGARA AERO HEAT EXCHANGERS are built in a range of sizes to fit any installation. Saving of cooling water quickly pays for the equipment.

Other applications include jacket water temperature control for process equipment or engines, cutting oils, lubricants, hydraulic oils, transformers, electronic sets, controlled atmospheres, compressed air or gas cooling.

Write for Bulletin No. 96-CA

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities

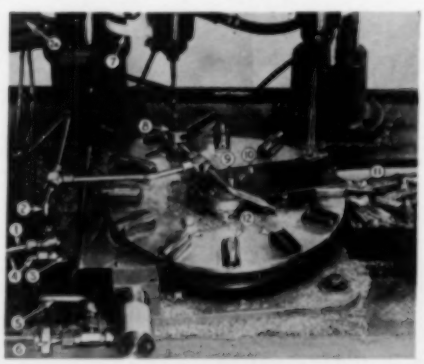
INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

be stacked or held in most convenient position for testing. Instrument will differentiate between annealed and unannealed steel bars, magnetic and nonmagnetic materials, and sort finished metal parts varying in composition or heat treatment. It is claimed that as many as 1500 small pieces have been handled in an hour. Comparator operates on 115-volt, 60-cycle current.

Mead Specialties Company of Chicago has recently brought out an improved model in its line of work-holding devices for drill presses and similar tools. Known as the Rotary Work Feeder, the apparatus was designed for use with two drill presses to permit the drilling and reaming of small parts in one continuous operation. Compressed air is used to power the turntable, to feed the drills, and to blow away the cuttings. Fitted with clips to hold the parts being machined, the turntable locks in place at each station, the operating valves being arranged to prevent motion except when the drills are clear of the work. With the table indexed, the drill-feed valve goes into action. A pneumatic timer controls the number of revolutions per minute and, through a 2-way speed-control valve, also actuates the air cylinder which powers the turntable. Parts to be machined are put in position by hand and are ejected automatically by a cam that is mounted so that the work will encounter it just after reaming has been finished. After once opening the air line, the operator need only feed the parts as the table revolves. The apparatus is flexible and can easily be arranged to take different sizes or lengths of material.



ONE-MAN FACTORY

A close-up of the device applied to the drilling and reaming of brass valve bodies. An air line, 1, from the master valve delivers a constant supply of air through a tube, 2, to the pneumatic timer 2a. The drill-feed operating valve 3, by means of the air line 4, powers the drill-feeding cylinder 7 to move the drill and reamer downward each time the table indexes. An air line, 5, from the pneumatic timer powers the indexing cylinder through 2-way speed-control valve 6. A replaceable drill bushing, 8, guides the drill, while chip blower 9 removes the cuttings. A finished part, 11, is being ejected from a loading station, 12, by ejector cam 10.

WARMS AIR SUPPLY

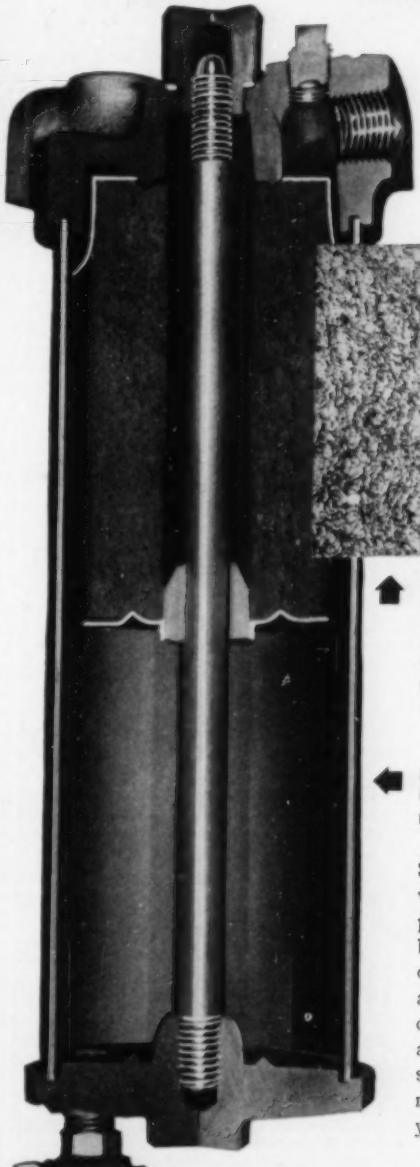
To alleviate the discomfort of breathing biting cold air through facepieces in outdoor winter temperatures or in refrigerated spaces, the Mine Safety Appliances Company offers the Airline Heater shown here. It was originally designed for wartime shipyard workers whose air supply was often chilled during delivery in exposed lines from compressors or other sources. The unit, which is attached to the wearer's belt, consists of an electric heater, heat exchanger, and thermostat, all encased in a rubber-covered cylinder 11 inches long and 2½ inches in diameter.

Applied by conventional spray, dip, or flow-coat methods, precure wax finish No. 3037 is recommended by S. C. Johnson & Son, Inc., for use on molded, extruded, or calendered rubber goods. It is said to prevent them from sticking during storage and also serves as a mold release. The compound permeates the surface, giving products a dry, satin finish, and will not build up molds through carbonizing. Its use involves no fire hazard.

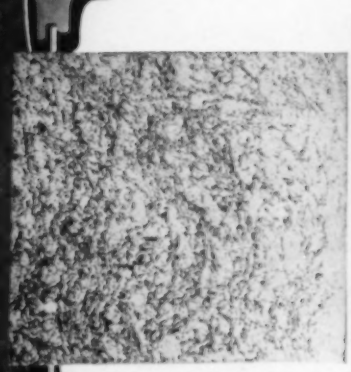
At Kure Beach, N. C., The International Nickel Company maintains a marine test basin where metal specimens are subjected to conditions they will encounter in actual service. Some are suspended from wooden racks that are lowered and raised by air hoists either to submerge them or to expose them to the attack of salt air and spray, while others are whirled through the water at high velocity. Panels are partly immersed to determine how they will resist corrosion, whether they will retard the growth of barnacles and other aquatic life, etc. To arrive at the answers may take but a few months, but sometimes years elapse before the investigators know which one of a series of metals and alloys is best suited for a given job, the purpose for which the basin was designed.

Dry Air

from the new filter with the longer-lasting cartridge



Air passing into MICRO-KLEAN FILTER first hits the baffle; any moisture not deflected, enters . . .



MICRO-KLEAN fibre cartridge where it must make hundreds of sharp turns through minute interstices, impinging on fibres.

Longer cartridge life is due to double dirt-collecting capacity and resinous impregnation which prevents wicking or channeling.

Moisture then drains from *non-wicking* fibres into extra-large collection chamber, equipped with petcock drain.

Standard Micro-Klean models handle volumes up to 80 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc. For more information, attach coupon to your letterhead.

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REMOVES MORE SIZES OF SOLIDS FROM MORE TYPES OF FLUIDS

Micronic · Disc-type · Wire-wound · Fabric Filters

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Means Lower Cost

On the job where claims give way to facts, France Metal Packings prove their exceptional value.

Because they are especially designed for tough going, they render continuous, trouble-free service under the most adverse conditions - producing savings in time, maintenance and money.

France Packings cause less friction, create less heat, consume less POWER and are gas tight.

Write Today for Free Brochure . . . "Industrial Packing"

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Industrial Literature

A series of folders describing the Hays line of strainers, measuring valves, and control valves for water, steam, and gas lines can be obtained from Hays Manufacturing Company, Erie, Pa.

Buyers and users of iron castings may secure analytical data on the characteristics and properties of process cast iron by writing for Bulletin 1115 distributed by McNally Pittsburg Foundries, Inc., Pittsburg, Kans.

Bulletin No. 32 of Eastern Machine Screw Corporation, New Haven 6, Conn., contains information that is helpful in selecting the proper die head for each threading application. Copies will be sent upon request.

Graphitic-iron piston rings for compressors and diesel engines are described in a 36-page catalogue offered by C. Lee Cook Manufacturing Company, 76 Beaver Street, New York 5, N.Y. Engineering data in the form of specifications, tables, and diagrams are included.

Raybestos-Manhattan, Inc., Passaic, N.J., has issued the sixth edition of a condensed catalogue on industrial rubber products. Among those described are transmission and conveyor belting, V-belts, hose, molded goods, rubber-roll coverings, tank linings, and abrasive wheels.

A 12-page booklet dealing with resin adhesives may be obtained from American Cyanamid Company, 30 Rockefeller Plaza, New York, N. Y. The brochure describes the company's products, illustrates their range of applications, and lists the advantages to be gained by their use.

Pipe and stud extractors built by Reps Tool Company, Inc., 94 Allyn Street, Hartford 3, Conn., are described and illustrated in a folder that will be sent upon request. The equipment is built to extract broken pieces of pipe up to 2 inches in diameter, as well as studs, screws, and bolts up to 3½ inches in diameter.

Form P-478, obtainable upon request, describes the electro-hydraulic tensile-strength testing machine produced by Thwing-Albert Instrument Company, Penn Street and Pulaski Avenue, Philadelphia 44, Pa. The instrument is made in several sizes ranging in capacity from 1 to 1100 pounds.

Kaukauna Machine Corporation, Kaukauna, Wis., will send, upon request, descriptive literature covering the firm's line of portable drilling and tapping machines. Six models are made for drilling, tapping, or spot-facing angular, vertical, or horizontal surfaces of castings and weldments.

Uses of Neoprene such as making hose for underground electric cables, binding for flexible grinding wheels, vibration absorbers, and coatings for wire rope are discussed in a recent issue of *Neoprene News*, copies of which may be obtained from E. I. Du Pont De Nemours & Company, Inc., Wilmington, Del.

Giddings & Lewis Machine Tool Company, Fond du Lac, Wis., has published a 266-page handbook on the subject of horizontal boring, drilling, and milling machines. Its 30 chapters are arranged in sections covering machine fundamentals, basic operations, and working procedures, and more than 325 illustrations help to explain the types of boring tools and the methods of supporting, aligning, adjusting, and operating them. The binding is of the loose-leaf type, and the plan is to mail data sheets on the latest developments in machining techniques to each book owner without charge. The price of the handbook is $5.00.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., has released a bulletin, Form 4065-A, describing its J-10 Utility Jackhamer, a lightweight rock drill designed for general work in the building, plumbing, and construction fields. A copy may be obtained from the company's main office or any of its branches.

A 52-page bulletin illustrating and describing its line of disk-type valves has been released by R-S Products Corporation. Designed to give information of practical value to users in selecting valves for industrial processes, the bulletin may be obtained by writing to the company at Wayne Junction, Philadelphia 44, Pa.

Mine Safety Appliances Company, Pittsburgh 8, Pa., will send, to anyone interested, information on the new carbon-monoxide testing instrument which the firm has developed from a model intended for war use. Applicable wherever there is need of a carbon-monoxide survey, the instrument contains an improved chemical that is said to detect the presence of the noxious gas in amounts of 0.001 to 0.1 percent by volume in air.

Two booklets on the subject of insulating firebrick and refractory cements have been issued by Armstrong Cork Company, Lancaster, Pa. They contain descriptions of the various types manufactured by the company and typical applications. Included are chapters on the physical properties of firebrick, as well as charts giving heat loss and heat storage at various furnace temperatures. Copies will be sent by the company upon request.

POPEYE by TOM SIMS & BILL ZABOLY
OH, ME POOR ACHIN' BACK!
HOW TO LIFT
BEND YOUR LEGS— NOT YOUR BACK
SPINACH ALONE AIN'T ENOUGH, POPEYE YOU GOTTA BEND YOUR LEGS!
TOM SIMS & BILL ZABOLY
THE COMIC WEEKLY

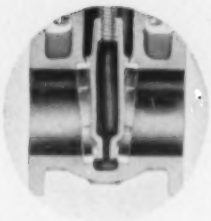
COMICS PROMOTE SAFETY

Posters bearing cartoons such as this one, featuring characters from eight leading American comic strips, are offered free by the National Safety Council. The artists are contributing their services to make this possible. A catalogue listing the posters available may be obtained from the Council, 20 North Wacker Drive, Chicago 6, Ill.

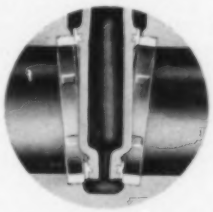
WALWORTH

iron body gate valves

with screwed or flanged ends



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.

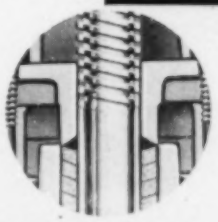


Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



Brass Liner on Glands assures greater resistance to corrosion and scoring.

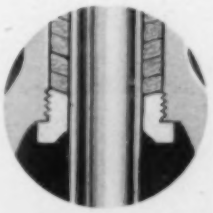
WALWORTH

valves and fittings

60 EAST 42nd STREET NEW YORK 17, N. Y.

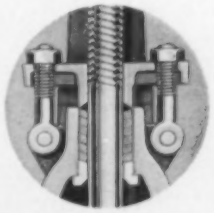
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.

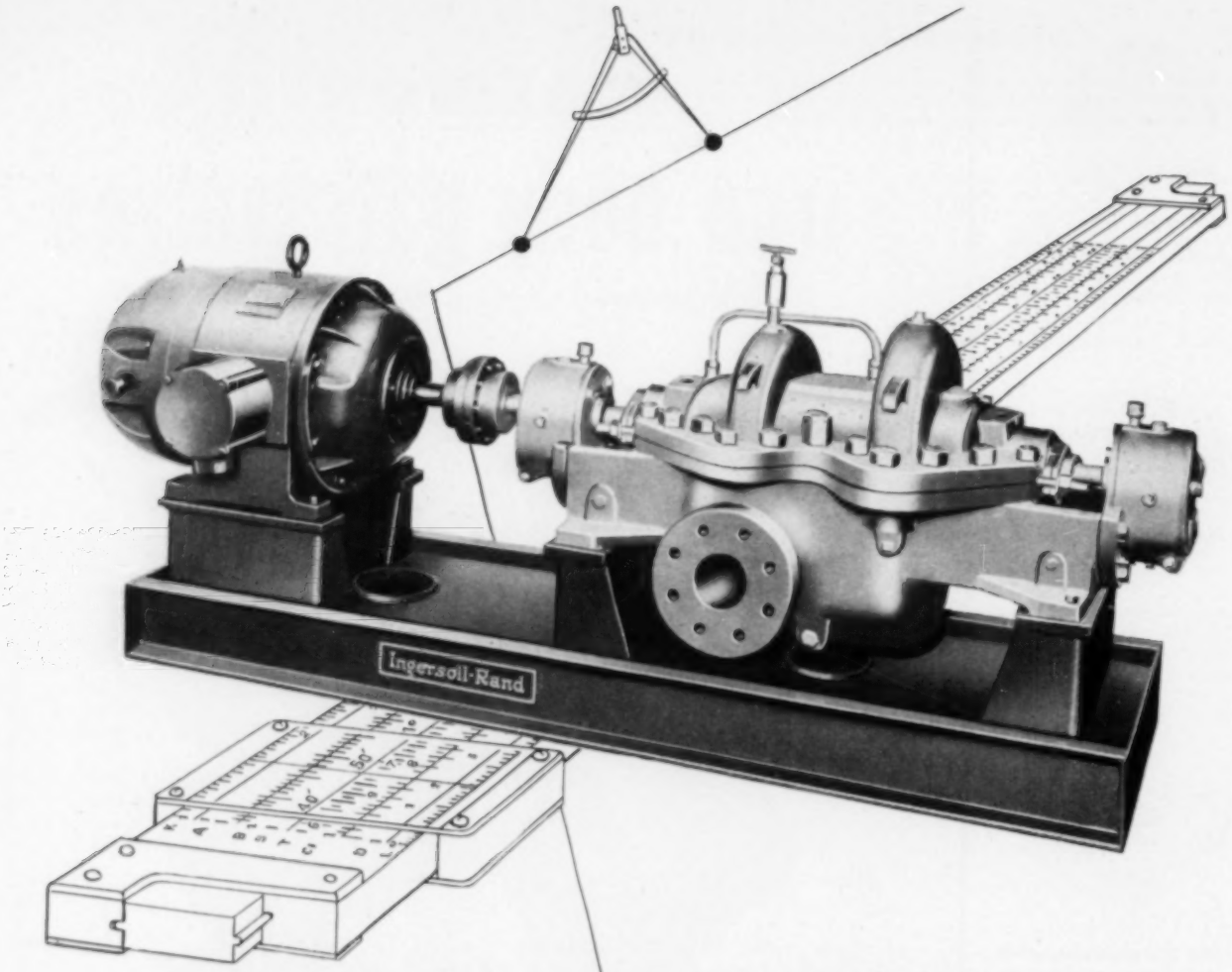


Bronze Back-Seat Bushings in bonnets of OS&Y valves.

Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.



Knowledge + experience = savings

A wealth of knowledge, experience and workmanship goes into each element of each boiler-feed pump produced by Ingersoll-Rand. This adds up to low maintenance costs, high efficiency and long life.

That's why the thousands of I-R units in service have established an enviable reputation for reliability and efficiency.

A perfect example of this is the GT, a two-stage pump designed to operate at modern motor, turbine and engine speeds. It is available in capacities up to 2200 gallons per minute for discharge heads up to 1050 feet (450 psi). This versatile unit is built to provide long, trouble-free service at efficiencies up to 85 per cent.

Call an I-R engineer. He will gladly help in the solution of your boiler-feed problems.

COMPRESSORS • AIR TOOLS • ROCK DRILLS
TURBO BLOWERS • CONDENSERS
CENTRIFUGAL PUMPS • OIL AND GAS ENGINES

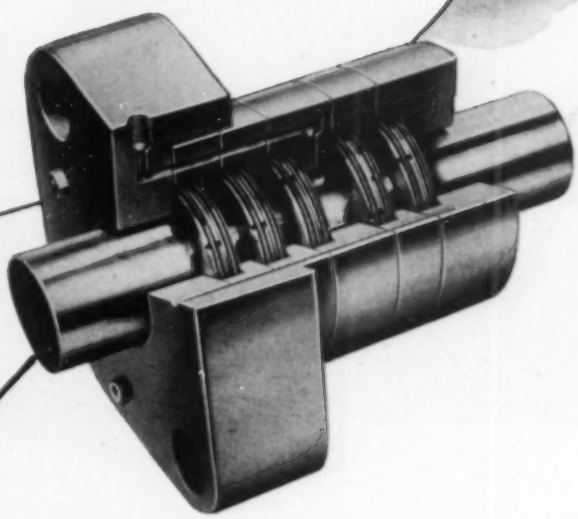
Ingersoll-Rand

11 Broadway, New York 4, N. Y.

69-10

BETTER PACKING FOR MORE EFFICIENT RESULTS—THROUGH METALLURGY

COOK PACKING RINGS are TINIZED



...to minimize friction and promote rapid seating!

Designed so that an oil film is maintained between ring and rod, Cook Metallic Rod Packings function with minimum friction. But like a bearing that must be scraped to fit its shaft, a perfect mechanical fit between ring and rod must prevail. Otherwise, the oil film is impaired and excessive friction and wear may develop.

To eliminate this possibility during initial operation, Cook packing rings are Tinized—a process by which the bearing surfaces are coated with an anti-friction bearing metal that enables the ring to come to a rapid mating with the rod and reduces friction to the lowest possible point.

This Tinized surface treatment is another exclusive Cook feature—one of many that will pay big dividends if you specify Cook Packing when ordering new equipment. For existing machines, address us direct, attention Dept. 6-C.

Sealing Pressures

Since 1888

C. LEE COOK MANUFACTURING CO.

INCORPORATED

LOUISVILLE KENTUCKY

BALTIMORE • BOSTON • CHICAGO • CLEVELAND • HOUSTON • LOS ANGELES • MOBILE • NEW ORLEANS • NEW YORK • SAN FRANCISCO • TULSA

This forging started right and will end right...

BECAUSE IT'S MADE WITH BASIC *Electric Steel*

● While the quality of the steel used is only one of many factors in producing exceptional steel forgings, it should be the first factor to consider in selecting your forging maker.

If your forging has a tough job to do, if it must stand up and give dependable performance over a long service life, if it must be capable of withstanding shock loads with high impact resistance, the character of the steel should be your primary consideration.

National Forge makes its own forging steel by the basic electric process—the process admitted to be superior for quality steel making. With the resultant finer grain structure and freedom from impurities, segregations and porosity, you can count on forgings with inherently greater strength.

Why not let us give you the technical reasons for specifying electric steel in your forgings . . . and also explain how the forgesmithing, heat treating and high precision finish machining are handled at National Forge. You'll buy better forgings if you let us place these facts in your hands.

NF

National Forge

AND ORDNANCE COMPANY

Irvine, Warren County, Pennsylvania

STEEL MAKERS ☆ FORGESMITHS

HEAT TREATERS ☆ MACHINISTS

BEARINGS THAT

Tame

THE HEAVY THRUST LOADS OF INDUSTRY

Heavy thrust loads no longer need shorten the life of vital rotating parts. SKF has *tamed* them with the Spherical Roller Thrust Bearing. Capable of carrying heavy thrust loads at high speeds, this bearing is built like a *watch* to do the work of a GIANT. It represents another SKF achievement speeding Industry's progress.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA. 6450

4 BIG FEATURES

1. THRUST CAPACITIES EXCEEDING 2,000,000 LBS.
2. ROLLING ALIGNMENT
3. CONTINUOUS OPERATION AT SUSTAINED HIGH SPEEDS
4. LOW FRICTION TORQUE

Helping to keep 9600 horsepower at a full gallop

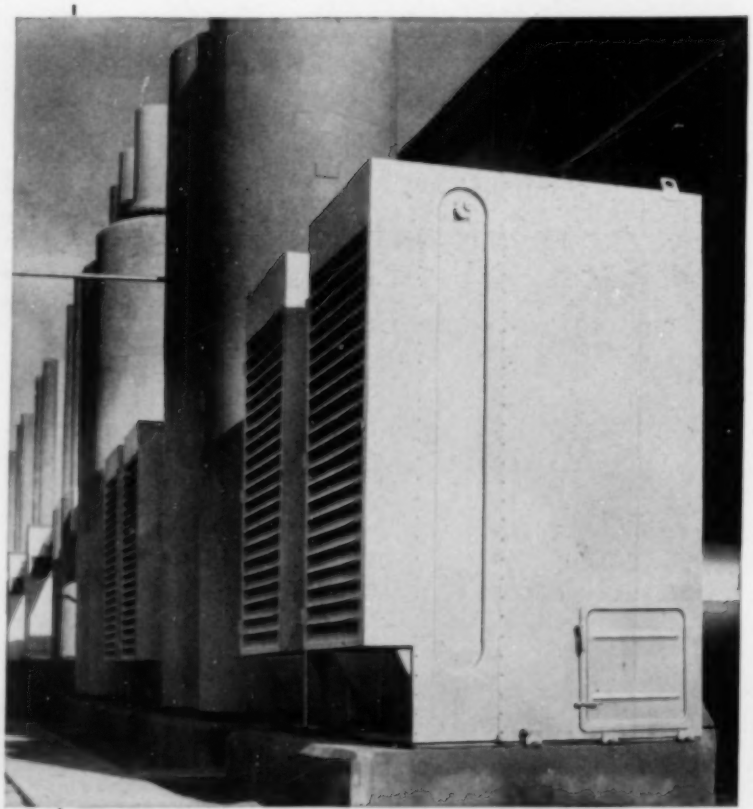
AAF MULTI-DUTY FILTERS ELIMINATE SHUT-DOWNS FOR REPAIRS DUE TO DUST DAMAGE

PRESENT day demand for petroleum products places a high premium on uninterrupted engine and compressor operation. That's why each of the four 2400 h.p. engines at this Kansas pipe line station are equipped with an AAF Multi-Duty Filter for protection against the damaging effects of dusts.

The Multi-Duty Type CMS is designed specifically for engine and compressor service. Overlapping panel curtain construction makes for positive, self-cleaning operation and delivery of a uniform volume of air. With operating resistance remaining fixed when once established for a given dust concentration, filter requires no attention other than periodic inspection and regular removal of sludge.

For outdoor installation, Multi-Duty Filters are supplied as housed units with weather louvers to protect filter curtain and a plenum chamber to which intake is attached. A perforated metal baffle in plenum chamber dampens intake pulsations and distributes air flow uniformly over the entire curtain area of the filter.

The positive protection of AAF Multi-Duty Self-Cleaning Air Filters represents pennies compared to the dollar damages caused by dust. Write today for complete information.



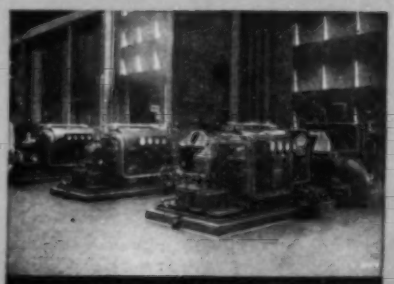
AMERICAN AIR FILTER COMPANY, INC.
402 Central Avenue, Louisville 8, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

FREE BULLETIN!
New Bulletin No. 150 contains complete data on Multi-Duty Filters for engine and compressor service.

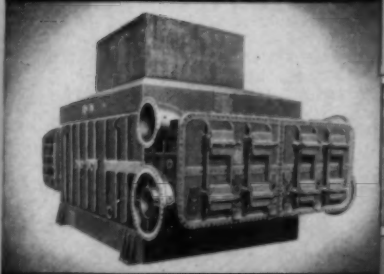
AAF
AIR FILTERS
AND DUST CONTROL EQUIPMENT

SHAPING INDUSTRIAL PROSPERITY

THROUGH GENERATING STATIONS



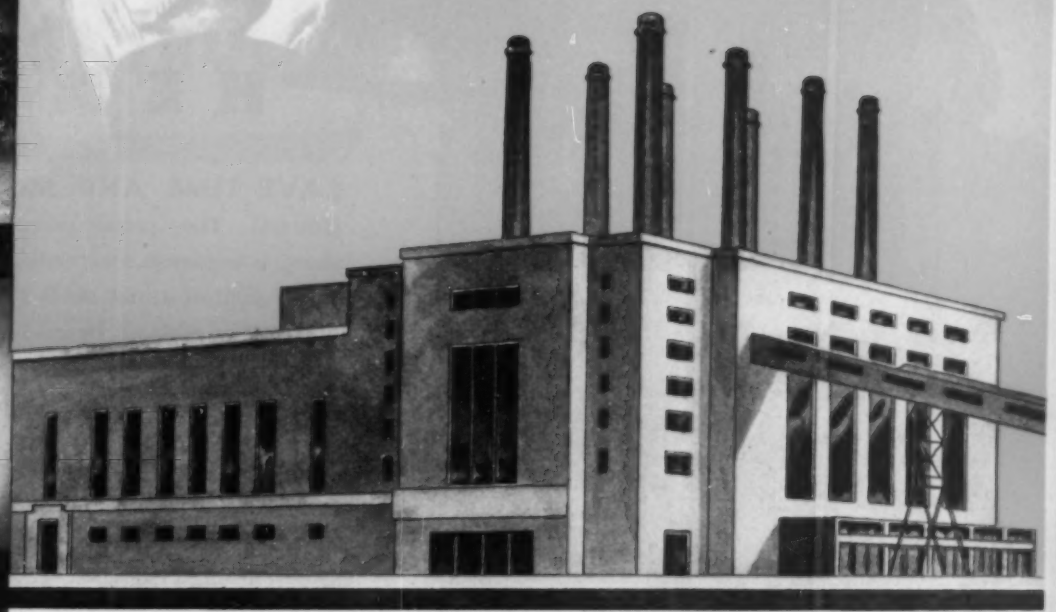
I-R Pumps for Boiler Feed System, Circulating, Condensate and General Service



I-R Condensers—Surface, Barometric and Ejector Jet Types

I-R Compressors for Instrument Control, Soot Blowing and General Service

I-R Portable Compressors and Air Tools for Service, Maintenance and Construction



Equipment made by Ingersoll-Rand was saving manpower and reducing costs eleven years before the first electric generating station took shape in 1882. Since then, Ingersoll-Rand products have been closely identified with many phases of the electrical industry.

During these 65 years electric generating stations have been indispensable in the Shaping of our Industrial Prosperity. Here is an industry financed by a million stockholders, manned by a quarter-million employees, expending a billion-a-year for fuel, maintenance and construction, serving 38 million customers—and market saturation is nowhere in sight—customer growth at the rate of 2 million a year.

Machinery built by Ingersoll-Rand is serving in most of the steam-driven generating stations. It has helped to build these plants and most of the famous dam projects for hydroelectric stations.

I-R Centrifugal Boiler Feed Pumps for pressures up to 3000 pounds per square inch—I-R Circulating, Condensate, Drip, General Service Pumps—Ingersoll-Rand Steam Condensers of all types and sizes—Diesel and Gas Engines—Compressors for instrument control and soot blowing—I-R Stationary and Portable Compressors and air-driven Rock Drills and Tools for excavation, tunneling, plant maintenance and servicing.

Ingersoll-Rand

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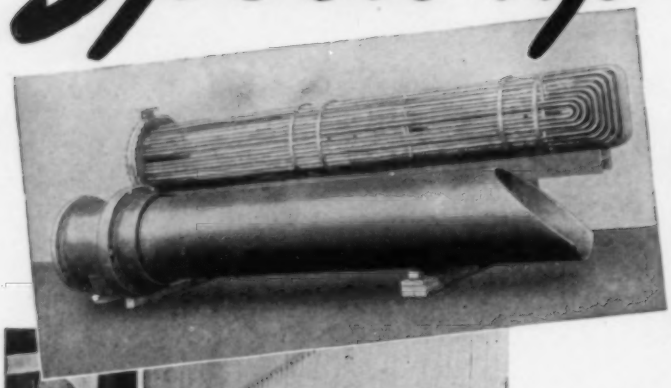
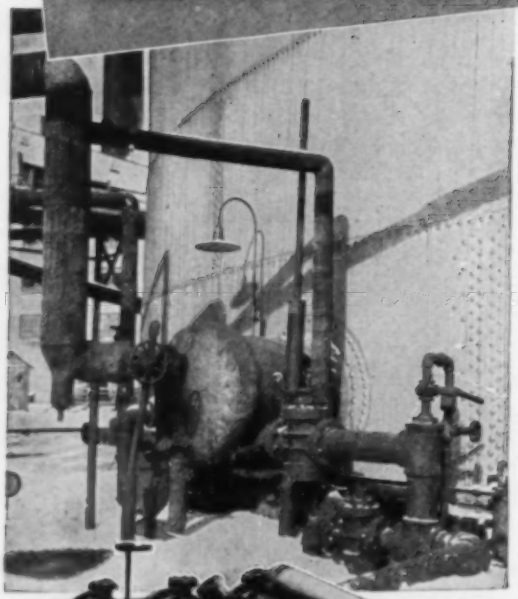
AIR & GAS COMPRESSORS • AIR TOOLS
TURBO BLOWERS • PUMPS
REFRIGERATION • ROCK DRILLS
VACUUM EQUIPMENT • GAS & OIL ENGINES

Speed up Oil Flow



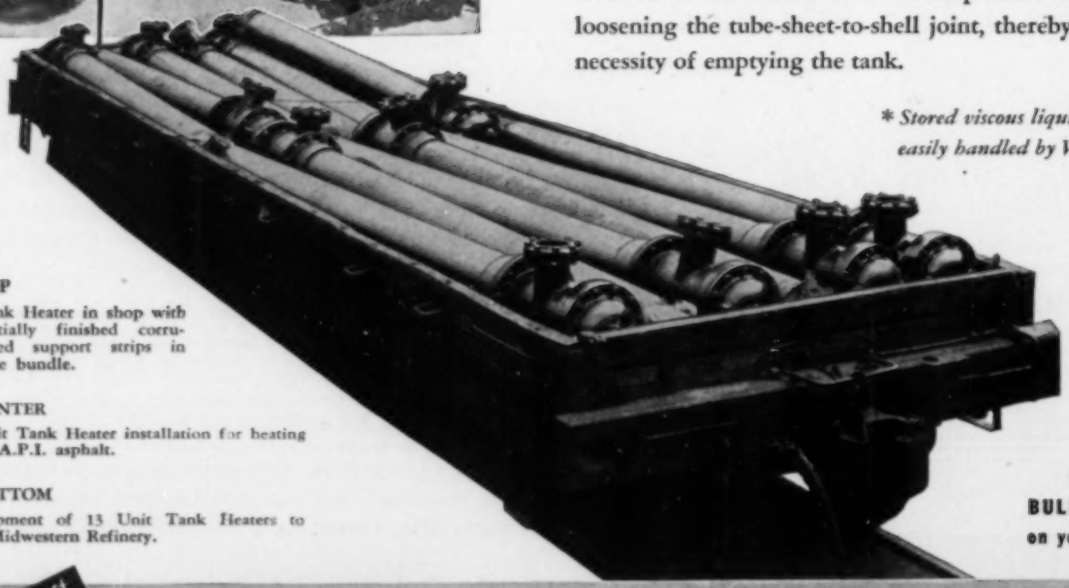
WITH Vogt UNIT TANK HEATERS*



SAVE TIME AND MONEY with Vogt Tank Heaters! They permit pumping to be started shortly after steam is admitted since only the small quantity of oil lying in the shell of a unit needs to be heated. As hot oil is withdrawn it is replaced by cold oil from the tank through the open end of the heater shell. Steam consumption is held to a minimum since *only* the oil removed from the tank is heated.

Standard Type U Heaters have nests of "U" bend tubes made from 1¼" seamless steel or 1" electric welded pipe, as desired. These are rolled firmly into tube sheets having double grooved tube holes. Corrugated strips support the tubes without impediment to the oil flow. Collar bolts permit removal of the steam head for inspection or repair without loosening the tube-sheet-to-shell joint, thereby eliminating the necessity of emptying the tank.

** Stored viscous liquids of any kind are easily handled by Vogt Tank Heaters*



TOP
Tank Heater in shop with partially finished corrugated support strips in tube bundle.

CENTER
Unit Tank Heater installation for heating 12 A.P.I. asphalt.

BOTTOM
Shipment of 13 Unit Tank Heaters to a Midwestern Refinery.

Write for BULLETIN HE-4 on your letterhead

HENRY VOGT MACHINE CO., INC., LOUISVILLE 10, KY.

Branch Offices: NEW YORK - CHICAGO - CLEVELAND - PHILADELPHIA - DALLAS

CHECK-REIN *for high-stepping* HORSE POWER WITH E-M "HI-FUSE" CONTROL

One of ten Hi-Fuse 2300 volt group assemblies, totalling thirty-nine panels for controlling sixteen induction motors and twenty-three synchronous motors at a southern paper mill.

HIGH-STEPPING horse power in today's industrial plants needs tight-reined control.

You can harness this rampant high-voltage with E-M "Hi-Fuse" Control for motors from 2300 to 4600 volts.

Horse-and-buggy day practice was to provide no short circuit protection. This was followed with a large, expensive, high-interrupting capacity switch. Contrast that with the new E-M "Hi-Fuse" Control system using the elements shown in the diagram at the right. "Hi-Fuse" does a thorough job of protecting and controlling your high voltage motors . . . "Hi-Fuse" costs you less. In every way, it's a better buy!

"Hi-Fuse" gives you these advantages:

SHORT CIRCUIT PROTECTION—current limiting type high interrupting capacity power fuses (up to 250,000 kva) cut off the short circuit current in a fraction of a cycle. Quick action saves motor and control from damage.

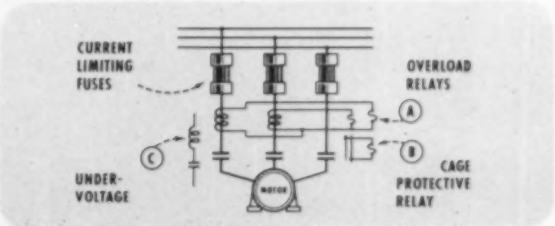
MOTOR PROTECTION—the current limiting fuses provide a means of disconnecting the motor from the line, as shown in the photo above. As the oil switch is not required to furnish short circuit protection, a smaller, less expensive switch is adequate. Coordinated with this switch and the fuses are overload and out-of-step relays to protect the motor from sustained overload, locked rotor, single phasing, under voltage, or too frequent starting.

POLARIZED FIELD FREQUENCY STARTING—in synchronous motors this "almost human" relay assures the highest synchronizing torque and minimum current in-rushing during starting. The Polarized Field Frequency system of starting was developed by E-M and for many years has been accepted as the best method of controlling the application and removal of field excitation of synchronous motors.

Here, then, is "Hi-Fuse" Control! It's the ideal system to give you the coordinated motor control you need in your plant! "Hi-Fuse" controls are available for both induction and synchronous motors, and are applicable generally without analysis of the short circuit current. For group assembly, both AC and DC buswork is provided. Segregated high and low voltage compartments and electrical interlocks help to provide for the safety of operators.

The "Hi-Fuse" Control unit is completely packaged ready for quick installation. It's attractive in appearance and strongly built. The doors are piano-hinged. Sturdy metal construction throughout.

Sum up what "Hi-Fuse" Control will do for you in your plant. You'll find it's the best buy for SURE protection and control of all your high voltage motors. Be sure to get full information about "Hi-Fuse" Controls NOW! Write for our technical bulletin 192.



● Simplified Connection diagram shows elements of protection provided for the motor in "High-Fuse" Control.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

3100-TPA-2073

E-M

Specialists in
BIG MOTOR ENGINEERING

DON'T WORRY, Mr. Sidewalk Superintendent, *She'll make the grade*

MODEL 148-DK

...OUR TRUCKS HAVE

WAUKESHA ENGINES

● Yes, sir, Mr. Sidewalk Superintendent, she made the grade all right. But it's not surprising that you wondered whether the truck could do it.

The truck driver wasn't worried. Not for a moment. He and his truck have been in tougher spots than that. But their Waukesha Engine pulls 'em both out *every time.* "Nuthin' to it," says he. "What those Waukeshas haven't got they don't need. They've got the horsepower—and I've got the horse sense to use it right."

The boss contractor isn't worried either. And he has to think of his trucks in terms of power costs, as well as power. That's why he *specifies* Waukesha Engines. He's buying dependability—with fuel and maintenance economy—when he buys Waukeshas.

Take the Model 148-DK Waukesha Diesel shown. 200 hp. at 2100 r.p.m. Six cylinders, 5¼ in. bore x 6 in. stroke, 779 cu. in. displ. At full output its exhaust is remarkably clean. It has a 7-bearing accurately balanced crankshaft—with crankpins and main bearings hardened to 600 Brinell. Removable wet sleeve cylinders, hardened to 400 Brinell. Chrome silicon alloy intake and exhaust valves; both valve seats are Stellite inserts. Full pressure lubrication. Big capacity oil filter. 24 volt electric starting system. Why not get all the details? Send for Bulletin 1413.

WAUKESHA MOTOR COMPANY
WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES

Long ago ...buying valves was simply a question of "how many?"

Long ago, when valve making was in its infancy, all valves were pretty much alike. So no one worried about what *kind* of valves to buy. But because industrial flow control requirements were equally simple, almost everyone was fairly well satisfied.

But not everyone! Because Powell, not content to "let well enough alone," introduced the first regrinding globe valve in 1865...and ever since then Powell has been producing "firsts."

And so today, Powell makes valves to satisfy all the diverse and complex flow control requirements of modern industry. The Powell Line of Valves for Compressed Air Services includes valves of all required types, designs and sizes not only for controlling the flow of compressed air but also of water for cooling the compressors.

As a result, there's still no need to worry about what kind of valves to buy—merely consult Powell Engineering.

The Wm. Powell Co., Cincinnati 22, Ohio

DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

Fig. 301—125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, outside screw stem, bolted flanged yoke, renewable bronze seat and disc holder with renewable composition disc.

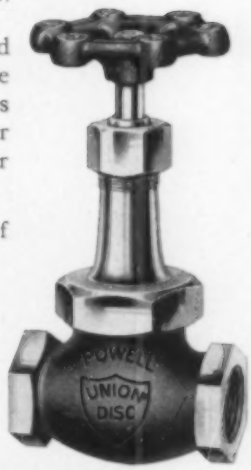


Fig. 150 — 150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

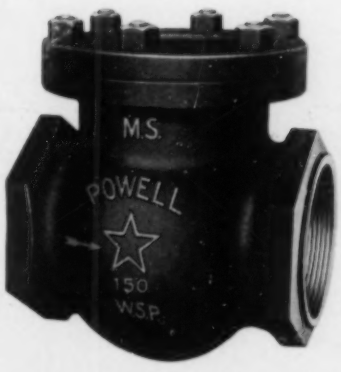


Fig. 311—150-pound Iron Body Bronze Mounted Horizontal Lift Check Valve. Screwed ends, bolted flanged cap, renewable bronze seat and vulcanized composition disc.

Fig. 95—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed cap, and regrindable, renewable wear-resisting bronze disc. Because of the cushioning effect of the plunger in the dash pot, the seating of the disc is practically noiseless.

POWELL VALVES

Smooth AND CONTINUOUS OPERATION HINGES ON THE Lubrication System

Fresh Oil, by the measured drop, from a **MADISON-KIPP** Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's *finest* machine tools, work engines, and compressors. You will definitely increase your production potential for years to come by specifying **MADISON-KIPP** on all new machines you buy where oil under pressure fed drop by drop can be installed.

"Our 50th Year"

MADISON-KIPP CORPORATION

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ANCIENS ATELIERS GASQUY, 31 Rue du Marias, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

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- *Skilled in* DIE CASTING *Mechanics*
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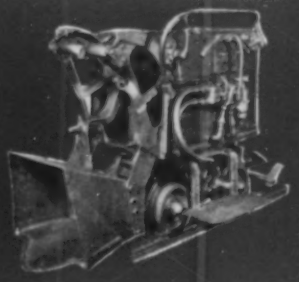
- *Originators of Really High Speed* AIR TOOLS

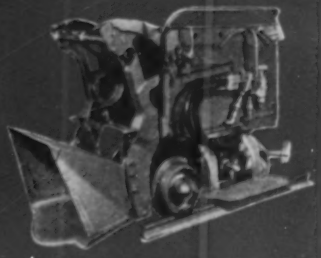
An Eimco is "hard-to-beat!"

RockerShovels are working in mines and tunnel projects all over the world. Year in and year out they do that kind of a dependable job that prompts users to say, "Better get an Eimco — they're hard to beat."

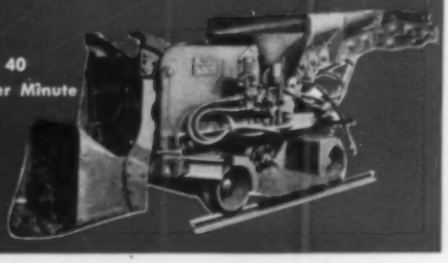
Consult Eimco Engineers on your loading problems. You will be under no obligation.



Model 12-B
1 Ton Per Minute



Model 21
2—3 Tons Per Minute



Model 40
4—5 Tons Per Minute

EIMCO

THE EIMCO CORPORATION

The World's Largest Manufacturer of Underground Rock Loading Machines

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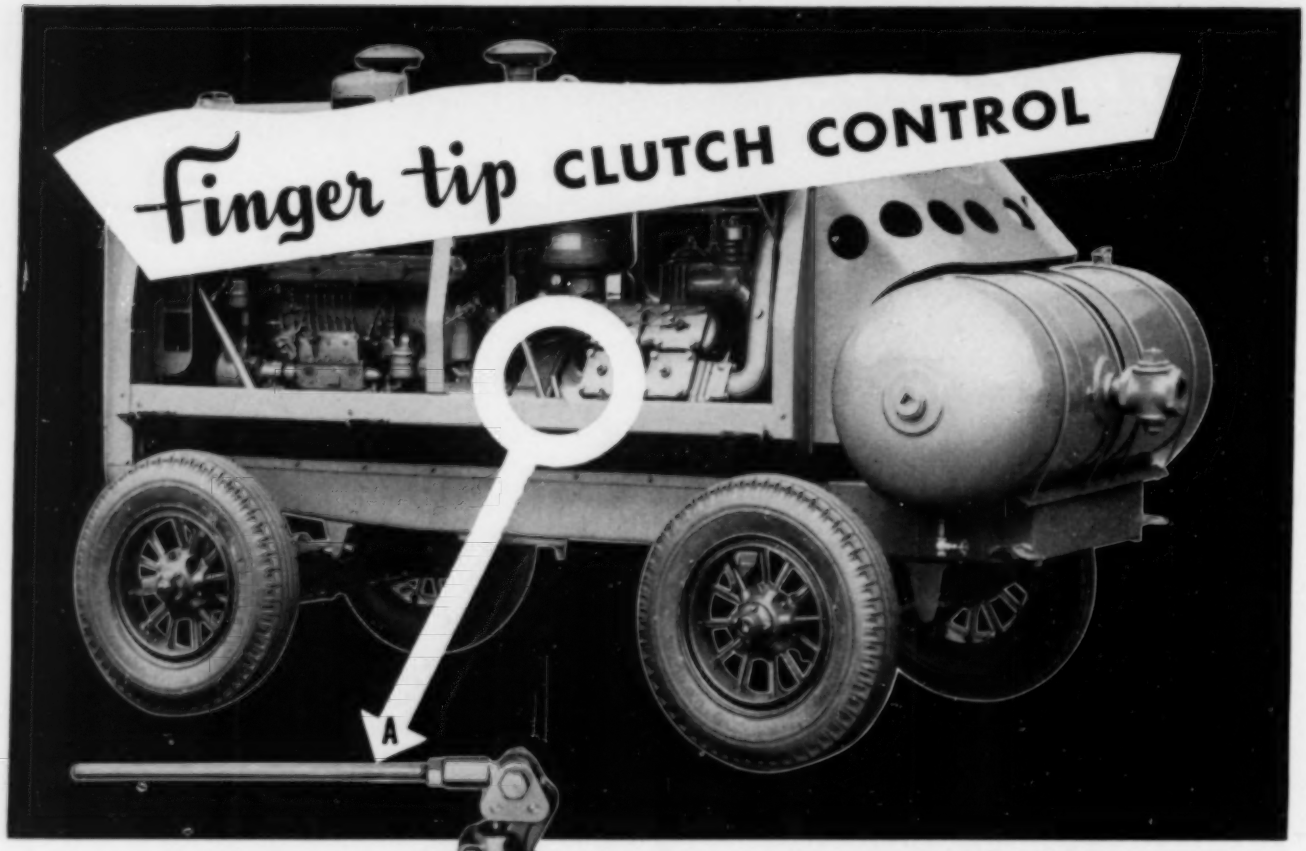
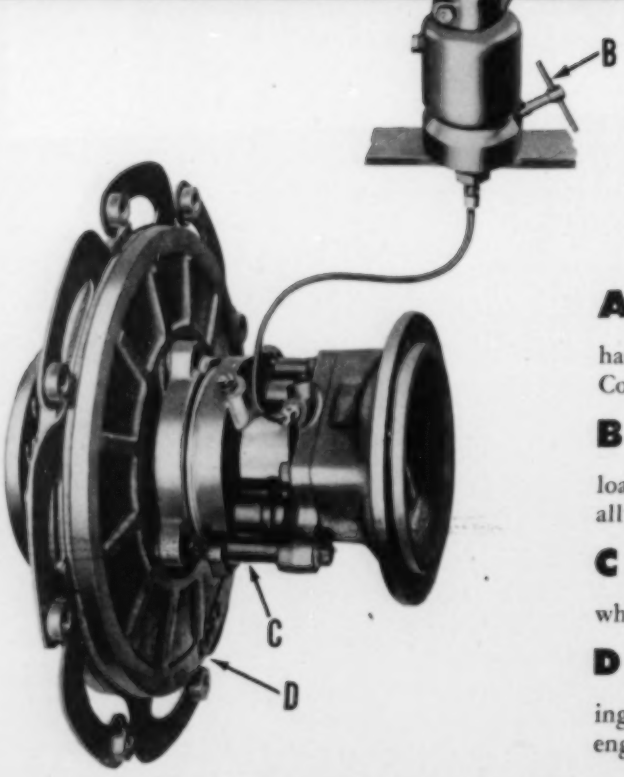




A contributing factor in the top-quality service of the new KA Series of I-R *Mobil-Air* Compressors under all conditions is easy, dependable clutch operation. These portable compressors are equipped with time-tested *Flex-Disc* Clutches now hydraulically controlled.

A The clutch is disengaged by two or three easy strokes of this accessible pump (hydraulic jack) handle shown at left and above in a Model HKA-500 Compressor.

B The clutch is engaged by a slight turn of this valve handle. The operation of the clutch, spring-loaded to 4300 lbs. pressure is easy and reliable under all weather conditions.

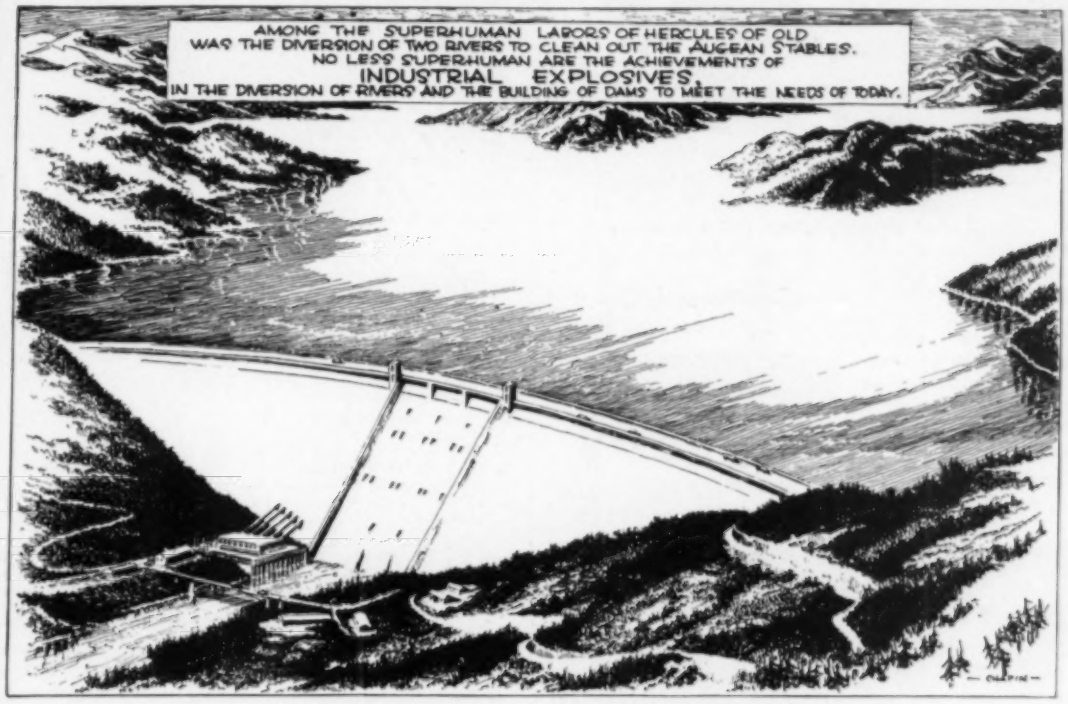
C A long and trouble-free service is assured by the dual jacks and ball bearing shift collar which actuate the clutch.

D The *Flex-Disc Clutch* is a dependable, low-upkeep clutch designed so that worn friction facings may be easily replaced without disconnecting engine and compressor.

INDUSTRIAL CLUTCH CORPORATION

Waukesha Wisconsin

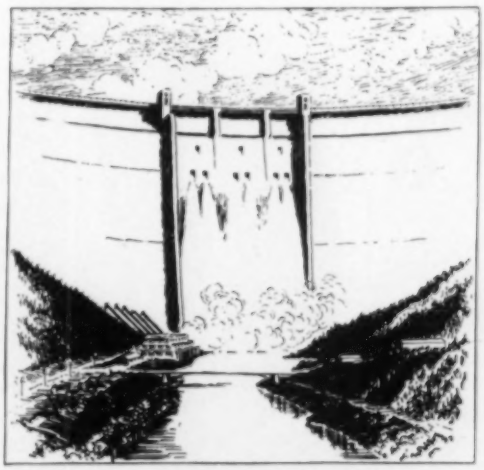
The Labors of a Modern Hercules — **DAMS**



AMONG THE SUPERHUMAN LABORS OF HERCULES OF OLD
WAS THE DIVERSION OF TWO RIVERS TO CLEAN OUT THE AUGEAN STABLES.
NO LESS SUPERHUMAN ARE THE ACHIEVEMENTS OF
INDUSTRIAL EXPLOSIVES,
IN THE DIVERSION OF RIVERS AND THE BUILDING OF DAMS TO MEET THE NEEDS OF TODAY.

EXPLOSIVES MAKE POSSIBLE THE DIVERSION AND CONTROL OF RIVERS IN CONSTRUCTING THE ENORMOUS FLOOD AND IRRIGATION CONTROL DAMS OF THE WEST. EXPLOSIVES GOUGE OUT TUNNELS, CARVE OUT ROADS, RELOCATE RAILROADS, BLAST THE ROCK AND STEEL AND OTHER NEEDED METALS WHICH GO INTO THESE HUGE WEDGES OF CONCRETE HIGH UP IN THE MOUNTAINS.

HUNDREDS OF WAGON-MOUNTED DRILL RIGS BORE THOUSANDS OF HOLES FOR EXPLOSIVES TO BLAST MILLIONS OF TONS OF ROCK.



EXPLOSIVES BLAST ROADS AND TUNNELS THROUGH THE MOUNTAINS WHICH SKIRT THE MAN-MADE LAKES BACKED UP AGAINST GIGANTIC DAMS.

THESE COLOSSAL MOUNTAINS OF POURED ROCK ARE EVEN HIGHER THAN NIAGARA. INVOLVED IN THEIR CONSTRUCTION, WITH THE AID OF EXPLOSIVES ARE THE EXCAVATION OF MILLIONS OF TONS OF EARTH AND ROCK AND THE PLACEMENT OF MILLIONS OF CUBIC YARDS OF CONCRETE, ORIGINALLY BLASTED FROM QUARRIES AS ROCK, AND MADE INTO CEMENT.

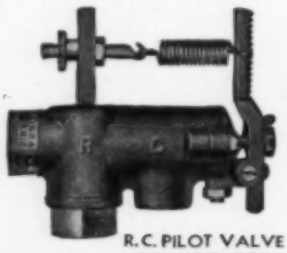
HERCULES

HERCULES POWDER COMPANY
932 King St., Wilmington, 99, Del.

XR7-Z

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U.S.A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.



R.C. PILOT VALVE STRAINER TYPE

R. CONRADER CO.
1207 FRENCH STREET - ERIE, PA.
PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

Cut Drilling Costs Three Ways . . . With "MINE KING"
"Standard of Quality" AIR HOSE

1 — Lower hose replacement costs. "Mine King" is built to stay on *the job longer,* under severest working conditions.

2 — Fewer connecting points and couplings. "Mine King" is available in extra long lengths.

3 — Easier handling. Extreme flexibility facilitates drilling in "tight" spots and coiling for transport.

Contact our nearest Branch for details.

GOODALL RUBBER CO., INC.
THE GOODALL-WHITEHEAD COMPANIES
Philadelphia • Trenton • New York • Boston • Pittsburgh • Chicago • St. Paul • Los Angeles
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BELT AND BASE PROTECT BEARINGS on this compressor drive

Here's how Schieren Duxbak belt on the pulleys and a pivoted motor base minimize wear on motor and compressor bearings.

1 THE SCHIEREN BELT has extra pulley grip which comes from a clean, uniform open grain surface. The extra pulley grip enables the belt to carry heavier loads at lower tensions . . . easing the stress on bearings.

2 THE PIVOTED MOTOR BASE provides automatic belt tension control. This provides instant compensation for overload with minimum strain on belt and bearings.

Write for complete, free information on Schieren belting and the modern pivoted base short center drive.

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35 FERRY STREET, NEW YORK 7, N. Y.
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Branch Offices in Chicago, Dallas, Denver, Detroit, Newark, New York, Philadelphia, Pittsburgh, Salt Lake City
Tanners and Manufacturers of Leather Belting, Packings and Specialties Since 1868

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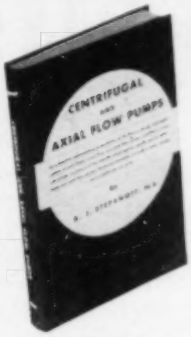


First Book-length Study of

CENTRIFUGAL AND AXIAL FLOW PUMPS

By A. J. Stepanoff, Ph. D.
Ingersoll-Rand Company

A study that's *not* just a discussion of elementary theory, but one of the most complete working manuals of theory, design and application ever available to pump engineers in this country.

Dr. Stepanoff covers the theoretical background necessary for understanding recent developments, and then gives an up-to-the-minute account of modern design in pumps—impellers, pump casings, and pump shaft design for critical speeds, as well as cavitation, axial thrust, and losses in centrifugal pumps.

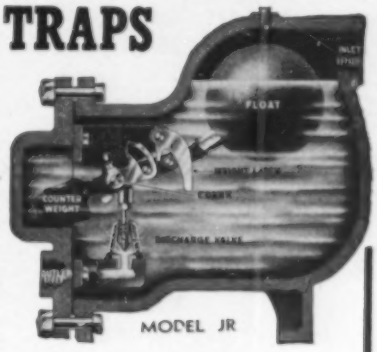
Finally, he discusses the problems encountered in operating centrifugal and axial flow pumps and deals with the precautions necessary to insure satisfactory operation.

February, 1948 428 pages $7.50

COMPRESSED AIR MAGAZINE
942 Morris St., Phillipsburg, N.J.

Assure Positive Drainage of Intercoolers, Aftercoolers, Receivers with Nicholson

NON-WIRE-DRAWING AIR TRAPS



MODEL JR

Wire-drawing is entirely eliminated in Nicholson weight-operated air traps by their positive, intermittent action. Valve opens wide instantaneously to discharge water and oil, after which it closes tight - - instantaneously. Other features: positive fluid seal against loss of air; not easily affected by dirt, pulsation, pressure variations; hardened stainless steel valve and seat. Rugged to take unavoidable abuse. Easily connected. 3 types; pressures to 1500 lbs.

BULLETIN 1047

W. H. NICHOLSON & CO. 180 OREGON STREET WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

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Square D offers a wide range of pressure, float and temperature switches for practically all sizes of water pumps, condensate pumps, vacuum pumps, air compressors, machine tools and other machinery involving pneumatic or hydraulic systems. Send for your free copy of Pump Control Catalog, with illustrations and specifications.

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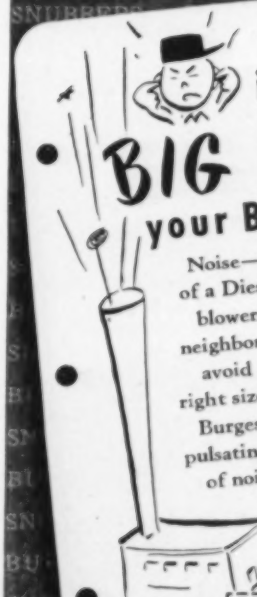

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Noise—from the intake or exhaust of a Diesel engine, compressors, or blower—will not be tolerated by neighbors of your plant. You can avoid it easily by installing the right size Burgess Snubber.

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Please send me information on Burgess Snubbers.
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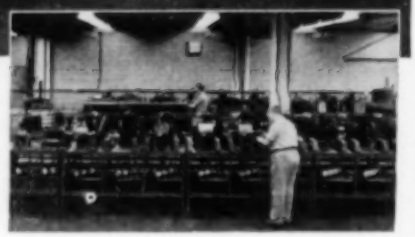


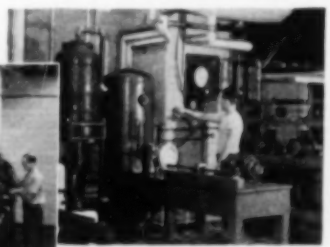
Testing Laboratories general view

Research

Starting in 1887 with the fundamental question—"what makes packing pack?"—Garlock has extended its research from year to year until the newly constructed building shown above is now required to house Garlock's research activities. Garlock products are developed, improved and refined in these completely modern chemical, physical and rubber-compounding laboratories; thoroughly tested in the fully equipped test department and processed in the pilot plant before ever reaching the production department. This *Quality Control* is your assurance of uniformly high quality in every product sold under the Garlock name.

THE GARLOCK PACKING CO., PALMYRA, N.Y.
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

Compounding Laboratory



Another section of Testing Laboratories

Chemical Laboratory

GARLOCK

DEPENDABLE PNEUMATIC SERVICE

WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT

DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper – resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

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AIR TOOLS SPEED WELDING

GRINDING

CHIPPING

SCALING

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Ingersoll-Rand Air Tools have contributed to the advances in welding, especially by improving the preparation and finishing operations.

Improve and speed up your welding and satisfy your welders with I-R CHIPPING HAMMERS for peening, beveling, root chipping, cleaning off excess metal . . . GRINDERS for cleaning, smoothing, polishing, wire brushing . . . SCALERS for cleaning, removing excess metal and spatter . . . DRILLS for studding . . . AIR HOISTS for handling heavy weldments.

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get your copy from your LE-HI distributor NOW, while his supply lasts! . . .

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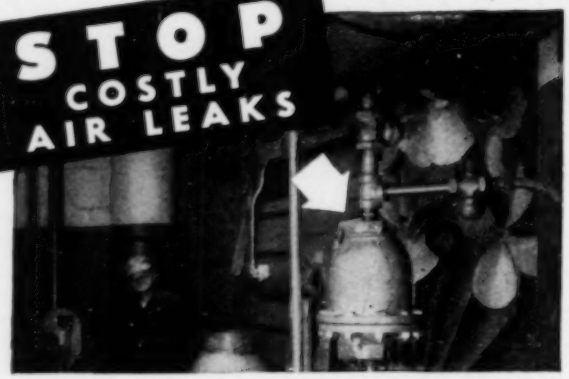
LE-HI HIGH and LOW PRESSURE HOSE COUPLINGS

STOP COSTLY AIR LEAKS



In the average plant, compressed air costs 10 to 20 times as much as steam. With manual blowdown of water from separators, aftercoolers, etc., some air generally is wasted. And if the operator fails to close the valve tightly, the loss multiplies rapidly. To prevent such waste, hundreds of plants have installed Armstrong Air Traps at every point where blowdown of moisture is necessary. In addition to saving air, these traps set a standard for dependability that is only possible with high quality automatic equipment.

TRAPS TO FIT YOUR REQUIREMENTS. Armstrong offers ball float, "snap-action," and inverted bucket air traps . . . sizes to fit any job . . . forged steel body traps for high pressures.

RECOMMENDATIONS. Quick facts on trap to use, how to install it, condensate rates, etc., contained in Bulletin No. 143—ask for a copy. ARMSTRONG MACHINE WORKS, 885 Maple St., Three Rivers, Mich.

ARMSTRONG *Air* TRAPS

Here's the New AIR PRESSURE REGULATOR

—That Pays for Itself!

SPEEDS UP PRODUCTION! You get fast action with Hannifin's new "Air Warden" regulator. No slow build-up to desired pressure. Saves time; helps do work faster.

SAVES AIR! Easy to back off air pressure without exhausting control valve. Regulator closes tight under dead end conditions; no pressure build-up. Use this new, economical regulating valve that's built especially for handling air. Ask for Bulletin No. NP-1005-U, HANNIFIN CORP., 1101 So. Kilbourn Ave., Chicago 24.

HANNIFIN AIR WARDEN REGULATOR

SAY GOODBYE TO EXCESS WEAR

The new Norgren Transparent Bowl Filter gives your air tools maximum protection 3 WAYS against destructive moisture, emulsions, grit and pipe scale.

1 **Tornado Jet drives out all water and emulsion.**

2 **Double Monel wire screen stops all solids.**

3 **Quiet zone, below baffle plate traps waste.**

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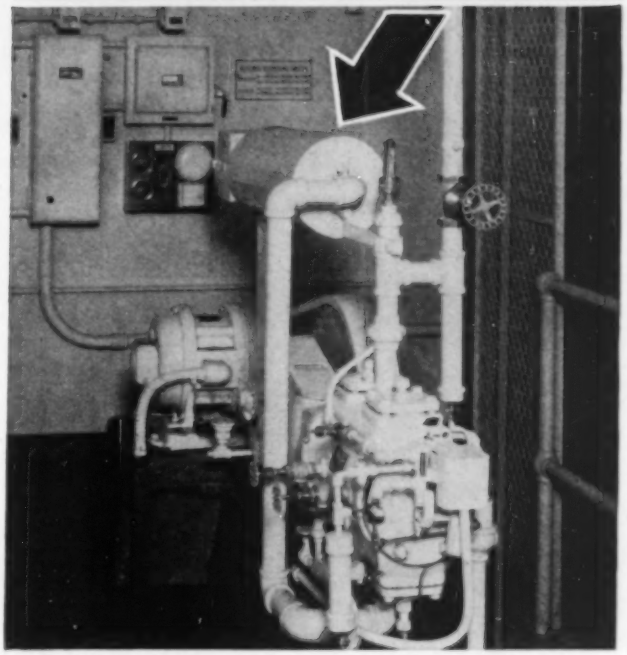
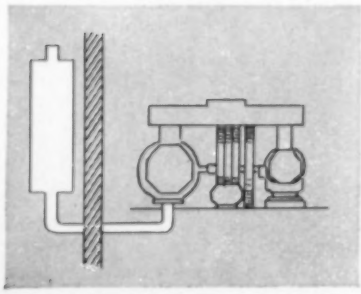
222 Santa Fe Dr. Denver 9, Colo.

Norgren

PROPER SILENCING MEANS BETTER OPERATION



The correct silencing equipment properly installed can make your compressor a good neighbor wherever you install it. Maxim intake silencers eliminate both noise and air borne vibration and insure quiet, efficient operation of compressors, large or small. It always pays to have a Maxim on the job.



There are several "right" ways to install a Maxim Silencer on your compressor depending upon location, space limitation, etc. Let our engineering department help you plan the best way for your particular conditions.

WRITE FOR FURTHER INFORMATION ON MAXIM SILENCERS FOR COMPRESSOR INTAKE AND DISCHARGE AND VACUUM PUMP DISCHARGE

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IN EVERY SIZE • OF EVERY TYPE • FOR EVERY PURPOSE

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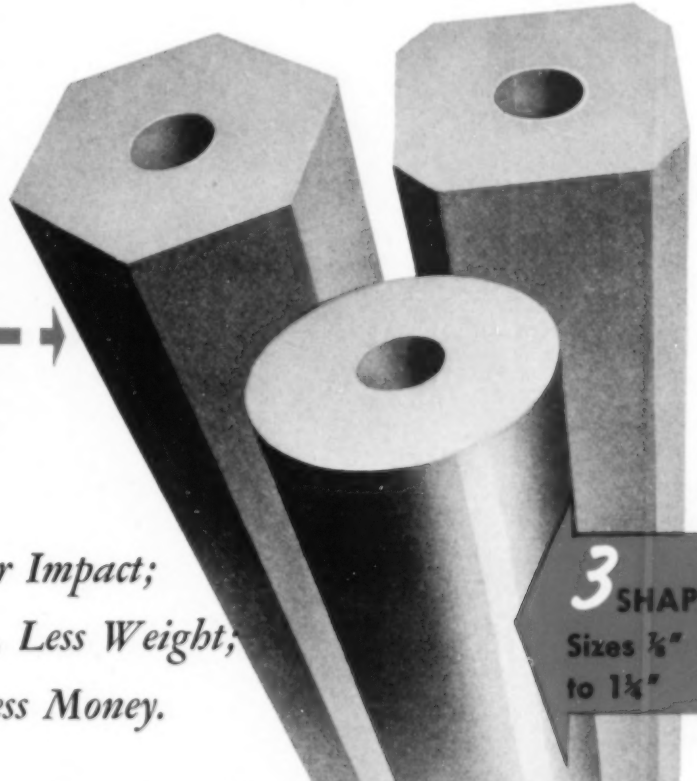
Here is CRUCIBLE'S

NEW "Park A" Alloy • hollow drill steel



Offers Longer Life Under Impact;
Permits Smaller Sections, Less Weight;
Makes More Hole for Less Money.

CRUCIBLE'S new "Park A" Alloy offers a big saving over the use of carbon drill steel in the cost of drilling with stud jackbits. Recent tests show savings in steel cost alone to be in excess of 30%. In addition, "Park A" Alloy permits maximum drill speeds; has longer life with stud jackbits; enables you to use a smaller section with the same size bit.

Crucible's new alloy hollow drill steel has been thoroughly tested, conforms to I-R Specification 139, and is recommended for jackstud insertion. Mill tests and inspections insure high quality and uniformity of every lot as to hole centering, size, and section accuracy, fatigue strength, stiffness, analysis, and structure.

Ask your Crucible CRUSCA drill steel salesman about "Park A" Alloy hollow drill steel. Get more hole for less money.

IMPORTANT! *New Data Sheet on Crusca "Park A" Alloy Drill Steel Just Printed! Write for Your Copy!*

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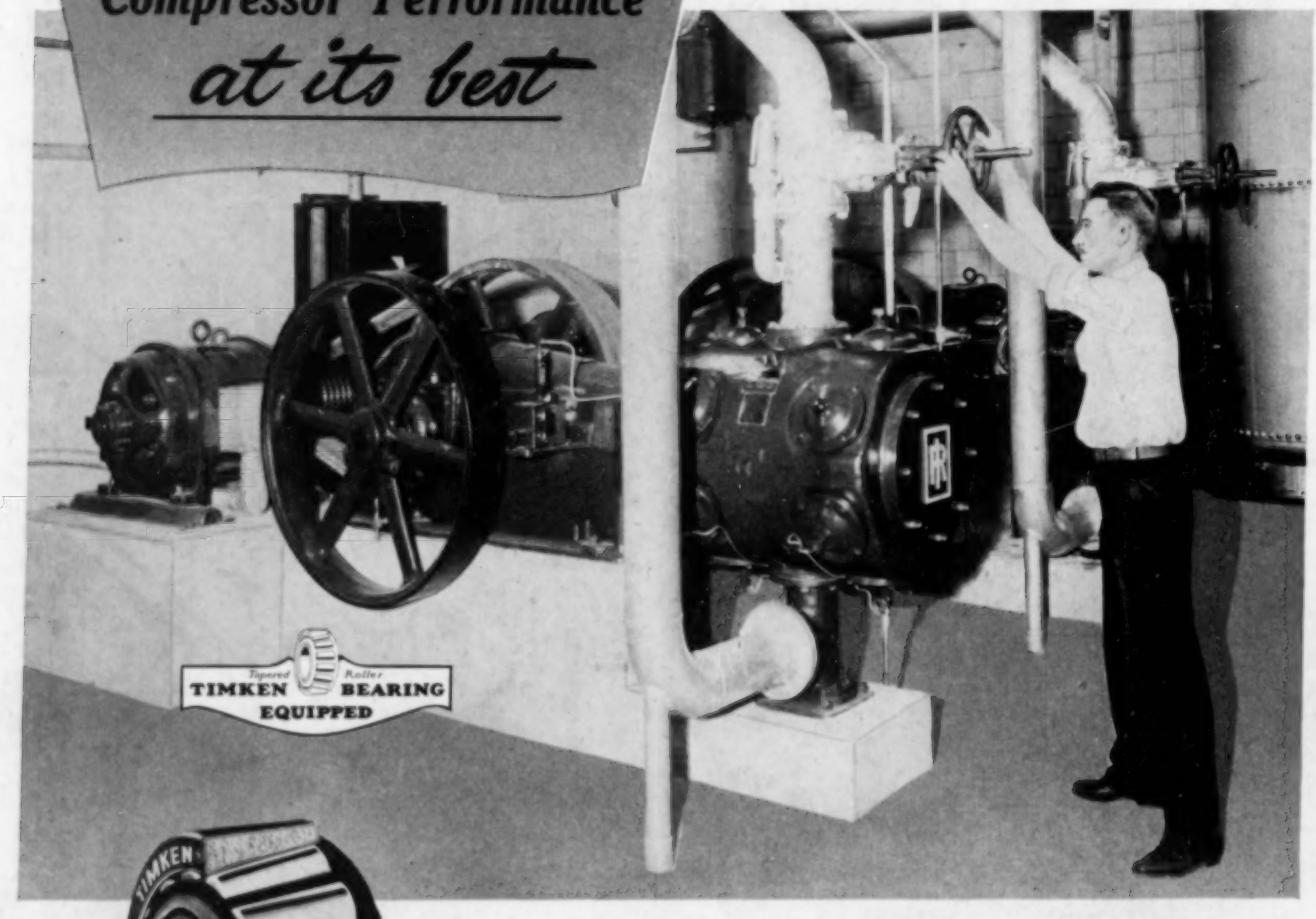
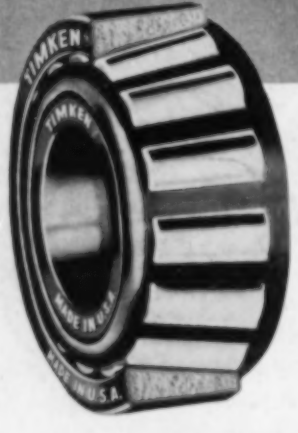
Get Anti-Friction Compressor Performance *at its best*

Ingersoll-Rand 15 x 11 type ES air compressors equipped with Timken Tapered Roller Bearings installed in glass manufacturing plant.





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